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NATIONAL SEMINAR ON SOCIAL RELATIONS OF SCIENTIFIC AND TECHNICAL CHANGE

APRIL 5–7 1983
HYDERABAD

PROCEEDINGS

EDITED BY
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OVERVIEW*

This National Seminar, held at Hyderabad during 5-7 April 1983, was sponsored by the Delhi Office of UNESCO. The organisers were the Administrative Staff College of India and the National Institute of Science, Technology and Development Studies. Over 40 scholars, natural and social scientists drawn from research and academic institutions, participated and presented some twenty papers.

Science and technology are integral parts of culture, albeit the fastest moving parts at present. The phenomenon of cultural lag whereby scientific/technical change outstrips socio-cultural change is now well recognised. It is sometimes argued that long term human progress is possible only when these two processes of change — scientific/technical and socio-cultural — are synchronic and symbiotic, which has not always been the case. The mismatch between the two is actually growing wider as the rate of scientific and technological change keeps on increasing exponentially, sometimes causing serious disruptions in society: moral crises, breakdown of established social institutions and relationships, mis-application of scientific knowledge negating nature and civilisation. At the same time, in certain other situations, a different type of mismatch is also visible: scientific and technological advances for betterment of the human condition have been hampered by backwardness and rigidities of the socio-cultural order.

The basic purpose of this seminar was to critically examine these inter-relationships between science, technology and society in general as well as in some specific terms, with particular reference to the situation in India in the Asian context.

Initially, the theme was subdivided into the following four components:

(1) Socio-cultural setting of scientific and technical change/progress, with particular reference to India as part of the Asian region.

(2) Interdependence between science and technology and the socio-cultural environment: adaptive and maladaptive relationships.

(3) Harmonisation of scientific and technical progress with socio-economic development.

(4) Awareness of the above processes and relationships among the general public and among decision makers.

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Despite a vast array of literature on policy and management related issues, the socio-cultural context of science and technology in India has remained largely unexplored and unanalysed. This has left a great many ambiguities in our understanding of the very notion of 'science and society relationship' in the Indian situation. Given the vastness and ambiguity of subject matter, participants were requested to contribute papers in line with either the above specific themes or the general seminar theme of social relations of scientific and technical change; to either cover the above issues in totality of the technology/science and society interaction or to explore them in depth through case studies on scientific and technological change/progress in certain demarcated dimension or regions of society.

THE CONTENTS

As the topics, abstracts and full texts of papers began to arrive, it became evident that some reorganisation of the stated themes would be necessary. The writers showed a remarkable degree of consistency in their approach and emphases while dealing with issues of selective concern, allowing the organiser, barring unavoidable analytical overlaps, to conveniently group the papers into four sections: (1) Science and Technology in the Social Context. (2) Science and Technology as Instruments of Socio-Cultural Change, (3) Impact of Society on Science and Technology, and (4) Science/Technology and Social Needs —the Development Perspective.

The scene was set with G.S. Sidhu's keynote address emphasising the role of indigenous science for social development. Indian science, Sidhu claimed, is now ready to absorb as well as generate the most advanced knowledge to solve local problems, provided the government and the public, particularly the industries, gave it encouragement over and above our traditional preference for readymade imported know-how. While recognising shortcomings, he also mentioned CSIR's overall capabilities and certain specific achievements.

In his brief inaugural speech, the Governor of Andhra Pradesh talked about the vast potential of modern science and technology for human welfare and emphasised using them essentially for this purpose.

BROADER SOCIAL CONTEXT

The broader social context for science and technology was laid out by A. Rahman and Aqueil Ahmad in the introductory session. Rahman started out by discussing the cultural and historical roots of scientific tradition, emphasising Western distortions of Eastern contributions to the development of science and technology right from antiquity through the colonial era to the present time. However, the major portion of his keynote presentation was devoted to a seething attack on the so-called anti-science movement in

India spearheaded by powerful obscurantist forces and certain religious groups who denigrate modern science as a Western formula to downgrade and destroy non-Western cultures, while ignoring India's own scientific traditions and emphasising her magical and mystical elements thereby causing greater harm to the development of science in non-Western societies than that caused even by the colonial powers. Rahman's presentation set the pace for things to come, and the greater part of the first day's deliberations were a lively, sometimes heated debate on this subject.

Aqueil Ahmad's theme paper, entitled "Western Science in Non-Western Cultures", recognised the role of modern science and technology (as developed in the Western countries during the past 300 years) in the recent-development history of non-Western societies and raised the basic question: Why did modern science fail to take root in Eastern societies despite their long standing scientific traditions: and why has it not been equally successful in different countries of the Eastern region as an instrument of socio-cultural change/progress. Citing comparative models of (modern) science and technology for development in Japan, China and India, Ahmad proposed four other related themes for the seminar: (1) identification of macro- and micro-level geopolitical and socio-cultural factors affecting the absorption, direction, development and application of Western science in non-Western culture areas; (2) the impact of Western science and technology on non-Western societies in terms of types of impacts, socio-cultural, economic, political, ecological, etc.; (3) the relationship between (the development of) science, technology and education in society; and (4) identification of factors which may lead science and technology in destructive or constructive directions. In the second part of his paper, Ahmad attributed the failure of a truly scientific culture to emerge in India to the conflict between three different levels or types of techno-industrial organisations, mentality or subcultures — the preindustrial (65-70 % of India), industrial (25-30%) and post-industrial (1-5%).

AS INSTRUMENTS OF SOCIAL CHANGE

The next session further highlighted and dramatised the issues raised earlier by Rahman. In their forceful paper entitled "Science in the Development of Indian Culture, with particular reference to the National Movement", Sanjay Biswas and S Chatterjee argued that "Scientific thinking had flourished to a great extent in the ancient Indian society" as indicated through signal developments in the fields of medicine, astronomy and mathematics. Quoting extensively from Debiprasad Chattopadhyay's monumental work, "Studies in the History of Science in India", Volume I and II, they rejected the argument that "global science is western science", and pointed out the outstanding contributions to modern science by such eminent Indian scientists and scholars as P C Ray, J C Bose, C V Raman, K S Krishnan,

D D Kosambi, S N Bose, M N Saha, Visweswaraya and others. The paper went on to detail some outstanding achievements of these men of Indian science and their influence on scientific thinking globally. With a clever turn of arguments, they tried to establish how the Indian scientific community in the late mineteenth and early twentieth centuries rejected the myth of our spiritual glory as an opiate of the people and, instead, derived "inspiration from the nationalist movement and took science as the platform for the struggle", despite the movement's "peculiar indifference to scientific progresss in the country".

H R Adhikari followed with a similar approach with reference to the "disparity between scientific progress and social development in India". He attributed this disparity to the failure of our "education system which imparts sufficient scientific and technical knowledge, but yet, is unable to develop a scientific outlook so essential for understanding the social importance of science". The hitch, according to him, "lies in our method of teaching science" which (1) emphasises only the factual basis of science without recourse to theory or experimentation to convey the dynamic elements, (2) creates too much dependence on, and uncritical acceptance of readymade 'facts' as presented in textbooks, (3) ignores the universality and social context of science, particularly the conflict between science and religions which is presented "as exclusively a Western phenomenon", while "a similar conflict in our own country—the development of science in ancient India and its untimely abortion by obscurantist forces — is mentioned neither in the textbooks (of science and history) nor in the more well-known and widely read supplementary source books". The rest of the paper was devoted to discussing the cultural and historical distortions connected with this conflict and suggesting certain corrective measures through the right type of scientific education in schools and colleges as well as through the popular culture.

Remarkable or unusual as it may be for a national gathering drawing upon heterogeneous sources without prior design or intent, in this seminar there were at least four formal and a number of other informal presentations where the authors had complete unanimity in their views on the nature of conflict between science and anti-science elements (e g, religious revivalist movements) in India and the implications for scientific and social progress.

S K Mhahjan picked up from where Adhikari had left off and further sharpened this line of argument in his presentation on "The Indian Science Movement and Its Opponents". He declared bluntly: "The conflict between science and religion has considerably sharpened in recent years". The main reasons for this, according to Mahajan, were fresh waves of attack on science in India by organised religious groups which "feel sufficiently threatened by the science movement, and emboldened by the state of confusion and uncertainty prevailing within the organised science sector in the country due to its poor performance". The other rea-

sons mentioned included the emergence of anti-science movements in several Western countries challenging the so-called Western S & T model which we too have been imitating and "the rise of religious fundamentalism in the West and the Middle East". Even more dangerous, Mahajan claimed, is the pretension by some fundamentalists that "there is no real conflict between science and religion" so eloquently made in the debate on Scientific Temper and Spiritual Values, at the Nehru Centre in Bomaby on 23-24 January 1983, in the wake of the statement on scientific temper (Mainstream, 25 July 1981) which "had sufficiently provoked certain religious elements to seek a debate with scientists". In fact, these elements "are willing to accept science only as long as it subserves the requirements of a culture and social structure based upon and dominated by religious interests and their ruling partners". His advice to all those who care to promote the nascent science movement, egalitarianism and material well-being in the country: "See through the game and refuse to make suicidal compromises for which pressures are bound to increase".

A large majority of participants were in basic agreement with the views on science and religion and scientific temper expressed by Rahman, Biswas and Chatterjee, Adhikari, and Mahajan, However, there were some serious challengers. Among these, it fell upon K I Vasu to come out as the so-called 'lone defender of the faith', for only he had a paper which was in direct contradiction to the 'scientific temper wallas'. The title of Vasu's paper, "Science and Social Harmony: The Need for Swadeshi Science Movement", was almost self-explanatory. His arguments, as if they were orchestrated through prescience as a planned rebuttal to the opposite views expressed earlier, ran as follows: Since technology is always socially and politically determined, and since science and technology are organically linked, science itself "can never be value-free or culture-free". Science can promote social harmony only when it embodies the material and spiritual ethos of a society; and therefore, science and social harmony in India can only be ensured through a swadeshi science movement, Furthermore, the encroachment in India by the so-called 'science culture' propagated by the West and the communists is rapidly displacing much of India's 'spiritual culture '. Scientific temper, a synonym for 'science culture' or 'scientific thinking' is "invoked not to instil faith in science, but to demolish faith in national culture and spirituality". Spirituality should be a foundation for morality, equality and economic-political ideology based on the principles enunciated in the vedanta, yogasastra and karma theory. The danger of aping the West lies in that materialism is "masqueraded as the scientific means for material prosperity". Alternatively, the swadeshi science movement would be based on a combination of dialectical spiritualism and Gandhian economics, whereby "science would not be allowed to become another 'opium of the masses', nor would scientific temper be allowed to become the amphetamine of the intellectuals....... . Science and technology

would be harmoniously blended with spirituality and integrrated with man, nature and culture...... to feed the growing population, shelter them, clothe them, educate them, employ them''.

A lively debate ensued, as to whether the Swadeshi or the modern science offered the better paradigm of action to meet basic human needs in India, or for that matter, anywhere in the world where these needs still remain unfulfilled.

IMPACT OF SOCIETY ON SCIENCE AND TECHNOLOGY

This session focused on the role of socio-cultural and political order in determining what one does with science and technology and how the priorities and methods so determined affect the various sectors and strata of society.

The opening paper, "Relations of Classes and Strata to Science and Technology", by Dietrich Wahl and M A Qureshi (presented by Qureshi), proposed that certain sections of Indian society, namely rich farmers, industrialists, merchants and the intelligentsia (i.e., government officials, managers, scientists and engineers) have a vested interest in the development of science and technology. They influence the direction of this development and invariably benefit from it, unlike the poor and the downtrodden who have neither any interest in or influence upon science and technology and the course of its development. Nor do they benefit from it. On the other hand, the middle class (comprising farmers and artisans in rural areas) and the working class (industrial workers) have an "objective interest in S and T to ensure higher incomes and for alleviation of labour". But being in a transitory stage in the ongoing development process, their approach and attitude to S and T is either mixed or indifferent. Some are aware of its potential (particularly the working class) and would like to use it, while others could not care less. There has been no political movement of any significance to alter the consciousness of the masses and bring science and technology closer to them, although "the possibilities of the existing order to provide strong social relations of the masses with science and technology do not appear to be exhausted".

In the following paper, "Fashions in Science, National Priorities, Neo-Colonialism and Third World Forests", Vinayak Purohit discussed how fashions and fads coupled with economic and political interest of the advanced industrial societies influence S and T priorities in the developing countries. For example, the current interest in the United States seems to be for developing alternative energy sources and preserving natural forests in the third world with the dual intention of curbing the rate of industrialisation there and letting the multinatioals exploit the forests to their own advantage. But for the developing countries these deliberate policy thrusts are merely fashions, unrelated to local urgencies, which have fallen off the imperialist table as crumbs "into the waiting and gaping mouths of the

recognition hungry [specialists]" offering them "glittering opportunities to travel abroad more frequently, publish more easily and build up careers more speedily". Purohit vigorously concluded:

> The shibboleths of 'international concern' and the need to 'limit national sovereignty in the interests of the world community' are mere claptrap....... The focus of concern [should not be] tropical forests but reforestation of Euro-America. The simple and equitable rule should be that he who pollutes should clean up.....Euro-American states must pay [annual penalty] to tropical third world nations for utilisation of forests and cleaning up the atmosphere.

While Purohit was concerned with the political economy of international science and technology systems dominated by the Western military-industrial complex and its impact on third world S and T priorities, Vithal Rajan's satirical "Essay in the Political Economy of Technology and Development" focused on the Indian political culture and the vested interests of its elite in our chosen path of development and accompanying technological choices, Rajan saw fascism, elitism and authoritarian modes of political and social conduct in India as a manifestation of a global political culture "in response to the world economic crisis", and raised the age-old but still fundamental issue of India's path of development: "Whom does it develop and who does it oppress? What is reality and what is hypocrisy?" His answers were provocative: "The real, concrete aim of our development strategy is political stability", thriving on the culture of power and a degenerative social process manipulated by the elite and their minions in the middle class, the clerks, bureaucrats, scientists and others. We suffer from eclecticism of the extreme variety: "everything is allowed as long as nothing matters",:

> A fascinating expression of this traditional eclecticism is the way the ruling elite is pro-everybody. The middle class is solidly pro-Western, its bureaucracy is naturally pro-Russian; and its very top elite is shrewdly pro-Chinese. This is everyman's Hunuman car. Capitalism is the chassis. Authoritarianism is the engine. And appropriate technologies are the gadgets.

The alternatives before us, Vithal Rajan contended, "may not be Green Revolution versus Red Revolution but rather some development versus real chaos". This would require informing the people correctly and giving them the inputs to become less dependent upon the ruling elite. This would mean putting an end to "buying to survive". This would emphasise "development of the community for the community, and not for the market". This would suggest inventing appropriate technologies for use and production, not for publicity. This would demand "decolonisation of the poor by the ruling class".

Yet another example of the impact of society on science was contained in Maithreyi Krisharaj's meticulous treatment of "the ways in which gender-relations influence the development of science and technology

in Third World Countries" despite the fact that generally such relations "are not even seen as at all relevant to the issue". The handicaps for women *vis-a-vis* the development of science and technology result from two interdependent conditions of the social structure: "the sexual division of labour and the power relations between the sexes within the context of a particular mode of production". Since women are not recognised as producers, "the impact of technology [on them] is often negative;....... even when the technology is extended to them as non-producers it is not necessarily, advantageous" because it is generally unrelated to their own priorities. To prove her point, Maithreyi cited several examples of recent technological innovations in rural India—such as community biogas plants, wood saving stoves, smokless chhulas, grain mills, food processing methods, etc — which have either ignored women's needs and circumstances or have adversely affected them while benefiting the menfolk who are the inventors and innovators of these technologies. To correct the situation, she recommended (1) removal of inequalities within the scientific establishment; (2) strengthening the role of women scientists in S and T planning for development; (3) recognition of women as producers "adequately involved in the process of generating technology"; and , finally, (4) equal status at home and outside for them to fully benefit from and contribute to science and technology.

The last paper in this session was by Vinod K Jairath, "Scientific Growth and the Nature of Scientific Community". Jairath attempted to identify some critical interdependent socio-cultural factors which way affect the growth of science over time. Included among these were (1) the division between mental and manual labour resulting in abstract knowledge, (2) certain values and attitudes, such as universalism and skepticism, (3) Utilitarian/technological levels achieved, and (4) the nature and extent of scientific community. Scientific community was defined as "a number of individuals, in a particular society, who are engaged in the pursuit of systematic knowledge about empirical reality"; and the requirements for it (the scientific community) to flourish and further the growth of science were to have "an institutional framework, a paradigm *a la* Kuhn, and effective communication". The rest of the paper further elaborated these requirements, implying a less than robust stature of scientific community in India to be the primary source of ill-health of Indian science.

DEVELOPMENTAL PERSPECTIVE

Next, the focus of the seminar shifted to policy, planning and management of science and technology for socio-economic development. Dhruv Raina had submitted a paper "On the Methodology of Preparing a Science and Technology Plan" to critique the NCST document called An Approach to the Science and Technology Plan (1973), with a view to augmenting his own current efforts in S and T planning at the Karnataka State Council

for Science and Technology. He recognised the role of "ideological components in any palnning process", found the criteria for technology choice (labour to capital ratio and socio-economic returns) suggested by the Approach paper not only ambiguous but also inadequate to help select technologies that could meet the stated developmental objectives; and recommended the involvement of social scientists in S and T planning and linking of the S and T plan with the socio-economic plan through state level agencies and institutions.

G S Aurora, however, raised a more specific question: "What is the effect of rapid development of a region on its delicately blanced ecology?" His observations were based on an earlier case study of some tribal groups in Himachal Pradesh. Aurora described in detail the geography and ecology of the region and anthropological characteristics of its original inhabitants who, for centuries, maintained a certain balance between the technologies used and natural resources available to them.. This balance was most visible in low population growth, longer cycles of shifting cultivation allowing rejuvenation of burnt forests, and energy from human and animal power, wood and water. All this began to change soon after the creation of NEFA in 1951 and subsequently its reconstitution as a union territory in 1972, with a view to integrating the region within the national mainstream and modernising it. First came the roads, followed by electricity, offices, industries and consumer goods. Collective labour was replaced in many places by wage labour; barter economy by market economy, conservation by expliotation of nature to the maximum for economic gains. Aurora concluded with the recommendation that electricity may be ultimately used for domestic consumption reducing the burden on natural forests, shifting cultivation stopped altogether in favour of rice cultivation in irrigated valleys and imports, and subsistence agriculture replaced by commercial forestry and horticulture; hoping that such a "shift in rural-urban relation will restore the ecological balance at a higher level of technology and culture".

G S Rao was concerned with using science and technology for economic development as a precursor of larger socio-cultural development. He regretted the slow rate of this transformation in India during the pre-and post-independence periods compared to Europe and America, pointing out the inadequacies of indiganous science and technology which may, however, have contributed more to agricultural than industrial progress which has been achieved largely through borrowed technology. The rich rather than the poor, urban rather than rural people, have been the major beneficiaries of this progress. Rao concluded that despite considerable progress made in recent years, "science and technology are yet to become a major force in the transformation of Indian society". His recommendations included technology imports in selected areas, indigenously generated production scale technologies on turn-key basis, small scale cottage industries for rural development, training of artisans and craftsmen, and large scale "educa-

tion of the village population in the application of science and scientific method in their daily lives".

Following a similar theme, V B Srivastava's concern with "Using Science and Technology for Development" cautioned against aping the so-called 'Western Model' by the developing countries and recommended "evolving their own S and T policies.... without demolishing old culture and traditions of science,...aiming at total human development, and improving mass communication to trigger the minds of people, spread awareness and motivate them to active participation in the change process".

Next, G Hanumanth Rao discussed "the methodology and mechanism of planning and execution of integrated rural development" through science and technology, in the light of his experience as a scientist with CSIR's Karimnagar project, started in 1972 in Andhra Pradesh. The project drew upon the expertise of several CSIR laboratories and collaborated with state level development agencies. The basic approach involved assessing the needs of people, surveying available human and physical resources in the district, and soliciting peoples' participation. Hanumanth Rao seemed to consider the Karimnagar project, 11 years after its initiation, a mixed case at best which encountered many difficulties but also achieved certain valuable results. On the negative side, he included unrealistic expectations, paucity of funds due to political and administrative vagaries, institutional inertia, and lack of proper organisation and coordination to "cater to the requirements of this multi-disciplinary and scattered activity". On the positive side, "a major gain of the project has been wide acceptance of science and technology as a deliberate tool for growth and development by the policy makers and the people", particularly with regard to certain appropriate technologies such as mini rice and maize mills, local materials, biogas plants; and housing, roads, water and sanitation technologies.

The last two papers on science and technology for development had a strictly sectoral approach, one dealing with "Government's Policy Towards the Drugs and Pharmaceutical Industry in India" by J Manohar Rao, and the other on "Medical Profession, Medical Technology and Health Care for All" by V K Kochar. Manohar Rao critically examined the evolution of Indian drugs policy beginning with the provisions contained in the Industrial Policy Resolutions of 1948 and 1956, the Foreign Exchange Regulations Act, 1973, various other acts and amendments over the years, and finally the 1975 Hathi Committee Report which led to the new drugs policy in March 1978. The policy "laid down some important guiding principles.... to reduce foreign domination in the drug industry by assigning a big role to the public sector, providing incentives for the Indian private sector and encouraging indigenous R and D activity". Rao concluded with the warning that "a number of loopholes exist in the new policy which may ultimately defeat its objectives" — such as the provisions regarding manufacture of high technology drugs, pricing, brand names, etc.

In a lengthy paper drawing mostly on the American and Indian experiences, Kochar discussed "the technological orientations of the medical profession as a culture group [with] linkages with elites, business agencies and other vested interests" and an ever increasing emphasis on "specialisation, mechanisation, medicalisation and bureaucratisation in the name of high quality medical care"...... "All this has led to increasing costs of medical care, alienation of the consumers, dehumanisation of patients, mystification of medical procedures, decline of general practitioners, neglect of preventive medicine, and denial of health care to the masses". Kochar came out strongly in favour of what he called "radical technology for primary health care" which would accord "highest priority to simple, more efficient and curative technology that can be acquired, learnt, propagated, and used by community health workers and paramedics with the least risk". In this framework, modern medical technology can also find its proper place, provided "its use is geared to the public good..... and it is not allowed to overshadow other more important priorities of the hospitals, the professionals and the health system".

The deliberations aptly concluded with a short slide presentation on "Technology, Environmental Pollution and Human Health" by Y R Ahuja, reminding everyone that, similar to the experience in the industrialised West, the price of mindless technological development and applications could be pretty heavy in the developing countries as well: in terms of physical pollution (e.g. radiation), chemical pollution (e.g. industrial effluents) and biological pollution (e.g. drug resistant bacteria and viruses).

INTERNAL DYNAMICS OF SCIENTIFIC PROCESSES

The three didactic papers can be grouped under the above sub-heading. One of them, "Teaching About Technology" by V Padaki and V Vyaslu, was submitted earlier, but could not be presented. The other two were submitted late and presented towards the end of the seminar.

Padaki and Vyaslu submitted a revised version of an earlier paper describing their joint experience as teachers of technology and development at the Indian Institute of Science, Bangalore, and some other forums in that city. Communication among peers may have a different quality than communicating with students, and teaching a traditional subject may have different dimensions than teaching hitherto unformed subject matter — as the two teachers found out for themselves. For instance, terminological clarity (definitions, classifications) and conceptual links needed to be rigorously pursued. For this, the authors found activity-based, participative teaching and learning most effective, where the technology-development-society (social change) link had to be continuously stressed through an inter-disciplinary and experiential perspective along with the link between content, method and the total context of the subject.

Amitabha D Gupta dealt with epistemological foundations of "Science and its Presuppositions", focusing essentially on what he called "the original sin of science" characterised by a "systematic rejection of the idea of Reason....as an instrument for changing the world in accord with man's rational faculties and ends". Consequently, scientific rationality has been transformed into a "technological rationality without having any end or telos of its own"....and the connection between science and human praxis is seen as a matter of empirical coincidence rather than a theoretical necessity. Gupta then went on to discuss three stages of conceptual development of science: science as new awareness, as fact and as a problem, and attributed the current crisis in science to the two later developments which have led to "technisation of science" distorting its true character "as human enterprise" for theoretical construction of a meaningful world.

And finally, Arif A Waqif examined from three different perspectives the intellectual, institutional, inter-personal and social processes or activities" through which science, technology and society interface with each other". The experts' perspective assumes scientific rationality, scientific temper, and "value-free and objective nature of scientific and technological processes". The users' perspective, "commonly held by resource owners, managers and administrators", is characterised by a concern for efficient management and exploitation of "science and technology for personal, sectarian, as well as collective gains". Both the experts' and users' perspectives have built-in limitations and dangers and cannot by themselves lead to a harmonious relationship between science and society. Alternatively, Waqif suggested an organic-naturalistic perspective on scientific and technological processes "in terms of their systematic relationships with economic, political, socio-cultural and psychological processes" — all related to the survival and growth of society conceived as a living organism, according to certain carefully identified natural laws governing social conflict, harmony and balance "between knowledge and action and between personal gains and collective gains".

CONCLUSIONS

What conclusions, if any, can be drawn from a rather grand intellectual exercise of this kind? One thing is very obvious: that all is not well with Indian science, and that the problems are far deeper than a cursory analysis and reallocation of priorities and funds would reveal or rectify. The problems seem to be rooted in the social order and culture, to the extent that the impact of society on science is felt in far greater measure than the impact of science on Indian society. Barring a few exceptions, seminar participants generally stressed the view that traditional structures and culture in present day India are restricting the development of modern science and technology rather than supporting or advancing them.

As the deliberations progressed, it also became clear that this particular seminar took a broader, all encompassing view of science and technology in relation to society with a degree of precision not commonly found in the on-going debate on the subject. This resulted in the identification and analysis of certain known but perhaps unexplored connectións between science and society in India, such as those regarding gender and class, scientific and intellectual perspectives, Western versus Indian science, subcultural schizophrenia, vested interests, power and powerlessness, etc — to name just a few.

A set of recommendations came out of the concluding panel discussion and they might as well constitute the conclusions of this report:

(1) It was noted that for various reasons, such as colonial machinations and local obscurantism and chauvinism, there has been a serious distortion of and alienation from, scientific traditions and movements in non-Western societies. These traditions should be brought closer to current scientific and technological efforts for overall social and cultural progress in harmony with local ethos.

(2) The presence of certain organised and unorganised anti-scientific forces in Indian society was recognised. These conflicts and dilemmas were to be resolved through popularisation of science and scientific temper amongall sections of the people along with the proof that science and technology can indeed improve the quality of their lives.

(3) Continuing inequalities due to vested interests and power-elite configurations were identified as the main factors working against collective improvement of the social condition, including the development of science and technology for the masses. S and T policy of the futUre must be geared to destabilise the existing power structure in due course of time, the sonner the better.

(4) It was felt that no society can ever hope to transform itself without high quality mass education. The need to link education, particularly science education, with the development of science and technology was strongly stressed.

(5) The seminar lamented the less than admirable achievements considering the vast S and T potential in India, and recommended that the nexus of social relationships within scientific institutions must be carefully examined to find out how the working environment for Indian scientists can be made more conducive to higher degrees of productivity and excellence.

SCIENCE AND TECHNOLOGY AS INSTRUMENTS OF SOCIAL CHANGE

WESTERN SCIENCE AND TECHNOLOGY IN NON-WESTERN CULTURES

Aqueil Ahmad*

INTRODUCTION

Cultural heritage is as old and as universal as mankind, for ideas and artifacts have been created and moved about within and between different culture areas even before recorded history. The older cultures have had more time than younger ones to generate ideas, but cultural age has not always been a plus point for social growth. A feeling of permanence and a heavy load of traditions can lead to inertia.

Science and technology are parts of culture albeit the fastest moving parts at present. The phenomenon of cultural lag whereby scientific/technical change outstrips socio-cultural change is now well recognized. It is sometimes argued that long term human progress is possible only when these two processes of change — scientific/technical and socio-cultural — are synchronic and symbiotic, which has not always been the case. The mismatch between the two is actually growing wider as the rate of scientific and technological change keeps on increasing exponentially, sometimes causing serious disruptions in society: moral crises, breakdown of established social institutions and relationships, misapplication of scientific knowledge negating nature and civilization. At the same time, in certain other situations, a different type of mismatch is also visible: scientific and technological advances for betterment of the human condition have been hampered by backwardness and rigidities of the socio-cultural order.

SOME CRITICAL ISSUES

The new nations of Asia, Africa and Latin America have been experimenting for some time with Western science and technology as tools of modernization and rapid social and economic transformation. In the Asian region, the experiences of China, Japan and India during the post-World War II period are noteworthy, for they offer three distinct approaches to using Western science and technology in combination with local traditions and

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resources and achieving different results. An observer of comparative social systems once noted in a lighter vein that contemporary Japan commercializes experience and achieves results, China massifies it and makes revolutions, while India mystifies everything and reaches nirvana. Can this be said of science and technology in the three societies as well?

That Western science and technology have played a dominant but differential role in the recent development history of these countries cannot be denied. Whereas Japan has followed what may be called the capitalist approach, China depicts a pure type of the so-called socialistic model with several clearly identifiable ideological phases affecting her policy for science and technology and their external relations wthout substantially altering the basic premises. The Indian science and technology system, like Indian society, economy and polity, is a mixed case embodying certain features of both the capitalistic and socialistic models in an inconsistent manner[1]. These approaches are clearly discernible in the manner and mode of organization, management, adoption, development and diffusion of Western science and technology in Japan, China and India.

A critical assessment of conceptual and empirical validity of these approaches/models and their societal implications at the highest levels of generality can pave the way for a more precise micro-level comparative analysis of interaction of Western science with traditional cultures. Combined, the two-level analyses may indicate convergence or divergence of these models, suggesting viable alternative ways for Asian societies to absorb, develop and utilize the best of available scientific and technical knowledge to meet local needs without much socio-cultural resistance and/or distortions and dehumanization. Such an outcome could have far-reaching policy implications for growth and survival with decency of not only the Asian countries but the entire third world, where developing advanced scientific and technological capabilities has become as important as preserving certain traditional structures and cultures now threatened by Western influences.

The notion of Western science as used here is not to deny the many non-Western roots of science but to delineate a distinct phase in the history of science (and technology) and the accompanying social and cultural dynamics stretching over roughly the last 300 years. That the Western science and technology so identified have dominated world history for about this period of time cannot be denied. What is not clearly understood is the dynamics behind such domination, the set of circumstances which might have been responsible for the tilt in favour of Western cultures or the handicaps generated during this phase for otherwise highly robust and vibrant non-Western cultures.

This second mega issue raises a number of other highly critical issues with far-reaching implications for the development of modern science and

1. *For further reference, see Aqueil Ahmad, "Science and Society in India and China: An Overview," Society and Science, Vol 5, No.1, January-March 1982.*

technology in third world societies today, the most important among these being the continuing domination of Western science, the extent of its alienation from non-Western cultural traditions, and prospects of socio-economic growth in non-Western societies with or without Western science and technology.

How society and culture affect the direction, rate of development and application of science and technology is not understood very precisely. The third set of issues posed here, therefore, relates to differential absorption and further development and applications of Western science and technology in non-Western culture areas in the recent past, say fifty to one hundred years; and identification of factors — socio-cultural, economic and political — which might explain these quantitative and qualitative differences. Here, science and technology are seen dependent upon certain macro- and micro-environmental variables.

The fourth set implies a reverse relationship: the impact of Western science and technology on non-Western societies in terms of various types of impacts — socio-cultural, economic, political, ecological, etc. Here, society and culture are seen dependent upon science and technology. However, in systemic terms, the processes underlying science/technology and society interactions in the third and fourth sets are interdependent, circular or multilinear — although not necessarily efficient, progressive or just.

The fifth set refers to the relationship between science/technology and education, both formal and informal. Education is a product of culture. It is also its carrier and promoter. No society has ever transformed itself without the aid of education. Artifacts — science, technology, arts, warfare and values — humanity, sensitivity, propriety, are the products of learning. If we want people to be human, we must teach them humanity. If we want them to be scientific, we must teach them humanity. If we want them to be scientific, we must teach them science and its values. A mismatch between social goals and education would lead society nowhere. I suppose it boils down to defining the social goals, choosing the best available alternatives for achieving them and developing and promoting the chosen alternatives by all possible means, including education, scientific education in particular.

And finally, we are confronted with the problem of preserving and enhancing the common cultural heritage of mankind along with the very survival of humanity itself. The role of science and technology towards achieving these goals in the third world context is of central concern to us. First and foremost is the problem of developing indigenous capabilities, to be innovative and to apply new knowledge to meet basic human needs without insult or injury to local sentiments and life styles. There is no dignity in poverty. Lasting peace cannot be achieved without prosperity and dignity for all. Science and technology are among the finest products of human creativity and ingenuity. They must also contribute to human dignity

and survival. If they do not, it is a cause of concern for all. We must then try to identify the forces which lead science and technology in socially undesirable directions such as war, injustice and corruption and prevent their utilization for betterment of the human condition.

SCIENCE AND SOCIETY IN INDIA: CROSS-PURPOSES

The above-mentioned areas or issues cover a broad canvas of what may be termed socio-cultural relations of science and technology, with particular reference to the so-called Western science in some non-Western culture areas. Their relevance to India is obvious, but our policy analysts and social scientists have paid scanty attention to them. Most of our S&T policy analysis has been polemical or (economic) developmental. Cross-cultural studies on historical and social origins and interconnections of science, technology and society have been sadly lacking. Consequently, we have failed to develop a coherent philosophy of the nature and relevance of modern science and technology for the Indian society of today and tomorrow in a global context. Modern science and technology in India, therefore, remain culturally rootless, and often in conflict with indigenous needs and traditions. In more practical terms, their own development as well as large-scale application have been thwarted despite some very sound policies and meticulous planning.

Controversies and contradictions abound, as they should in a society. with so many highly educated people, but some of them are simply outrageous. For instance, a hurriedly formed regional party was recently elected to power in one of the Southern states of India invoking a "return to Ram Rajya" and went ahead quickly to appoint several high powered advisory(to the government) commissions — on science and technology, energy, environment — under the guidance of an eminent scientist. Sai Baba, a renowned godman and guru of a powerful section of the scientific community, has established a university to teach "science and technology" for the welfare of society. Many people say Gandhiji was anti-West and anti-Western science and technology. Others contend that he would have accepted whole-hog modernization of Indian society if he were alive today. I know staunch Gandhians who are using advanced methods of cultivation and cattle farming and do not hesitate to own cars, TV sets and refrigerators. There is a strong intellectual lobby which has made "appropriate technology" their business, indiscriminately — which means big is bad, small is beautiful, indigenous is sacrosanct and appropriate, and using Western technology no matter how efficient means alienation and nation sellout. On the other extreme are scientists, administrators, businessmen and industrialists who consider West as best, indiscriminately; who constantly degrade indigenous traditions, including local R&D efforts, and would like to follow the "Japanese model" all the way, which means free imports and commerce and multinational corporations.

There is a close connection between science and language, between Western science and Western languages. This has posed a serious dilemma to non-Western societies experimenting with Western science. Japan has found an ingenious way of Japanizing the Western metaphor by slight linguistic twists. China employs one of the world's largest translation services to convert Western literature into the Chinese idiom. In India, we have nothing of this sort going, except endless debate on the morality and usefulness of teaching and learning English.

Such contradictions are as much part of Indian economy, politics and bureaucracy as of society in general. The result is endless compromises, ad hocism, hodge-podginess, and lack of single-minded devotion or direction to societal problems and problem-solving strategies. It is a truly mixed (or mixed up) situation, to let "hundred flowers bloom" haphazardly in a vast array of shapes and colours. It is also a mixed blessing: we have avoided totalitarianism and preserved a relative degree of freedom for private initiative and action, even at the cost of public good.

Many people praise or blame democracy for this mixed (up) state of affairs, for lack of strategic demarcations in the matters of public versus private, foreign versus indigenous, rural versus urban, science versus religion, tradition versus modernity, freedom versus accountability, etc. This would indeed be true to some extent in any society, let alone a democracy where freedoms are supposed to be greater. But we are not the only democracy in the world, or in Asia for that matter. We are not the only modernizing democracy with long-standing traditions and authoritarian subcultures either. Japan has the world's highest per man-hour productivity today. Japanese pride and reverence for kings, ancestors and firms and families and their masters are supposed to explain this signal phenomenon. Sri Lanka, a small democracy with little indigenous techno-industrial capability and a per capita GNP of only $200 has one of the world's highest Physical Quality of Life Indexes (82 on a 0-100 scale next to India's 41)[2]. Democracy or no democracy, some degree of national consensus on social goals and strategies seems imperative for progress.

A European scientist recently observed with appreciation that Indians displayed happiness and depth despite poverty and degradation next to the tensions and shallowness of the West despite power and affluence. That Indians, even the poorest, could intellectualize misery and philosophise existence was attributed by him to the depth of our psyches produced by an uninterrupted culture of five thousand years. Deep cultural and psychological roots — being happy, contented and philosophical under any circumstances — are indeed great virtues but they have their own drawbacks.

2. *POLI combines infant mortality, life at age one, and literacy into a single composite index that represents a wide range of social conditions, " cf. Todd R. Greentree and Rosemarie Philips, "The PQLI and the DRR: New Tools for Measuring Development Progress," Communique, Overseas Development Council, Washington, D.C.*

Survival may be taken for granted five thousands years back and forth, this way or that way; misery may be rationalized fatalistically; time may become timeless; the past rather than the future may remain forever the guiding force; endless reflection may prevent quick action and implementation. Western science and technology and many of their positive and negative impacts are products of the opposite cultural traits. India, along with the other Asian societies similarly characterized, will have to make necessary cultural and psychological adjustments if they chose to critically absorb and rightly benefit from the Western experience.

These conflicts or contradictions are intimately connected with the state of science and technology in society in a broader sense. They arise out of the uneasy but not uncommon interaction between forces of change and the status quo, modernity, and tradition or, in the case of colonial societies, between Western and non-Western sub-cultures. These concepts are imprecise and do not convey much. They equate Westernization, modernity and change with progress; non-Western values and traditions with the status quo, and these together, with backwardness. They imply valuational resistance to change as a given and this as the greatest, stumbling block to social progress.

None of this seems to fit in the present context. The West has gone full circle many times over: from barbarism slowly to rapid social progress, to self-destruction through wars and excessive growth, to stagnation through self-doubt and lack of direction, to emerge a bit more confident and ready to start moving again. The rate of techno-economic growth has been fastest in the Southeast Asian region, where traditions, religion, even magic and superstitions abound. Unexpected wealth in the desert kingdoms has helped former nomads to transcend centuries in a short span of one decade in the economic sense despite continuing scientific and technological backwardness. A lot more than the proverbial conflict or consensus between tradition and modernity, between East and West, seems to be involved.

Many years ago Lewis Mumford and Jacques Ellul (and later, Theodore Roszak and others) talked about the moral decay in Western civilization caused by extreme technologism. Daniel Bell offered the notion of "post-industrial society" as an emerging answer to the dilemmas of the industrialized West. Then there were the revivalists of all sorts, evangelists and mystics posing as saviours and messiahs and offering spiritualism as an antidote to technologism. Now, Alvin Toffler has turned it all upside down by invoking a "third wave" of the future surging across continents through microelectronics. The "third wave" is supposed to be all-encompassing, a totally new form of social organization — business, industry, work, leisure, family, friendship — all shaped by the advanced technologies of the future. Toffler sees a great deal of turmoil in the Western world due to the clash between the new "third wave" and the dying "second wave", created by the industrial revolution. This turmoil will continue until the new wave

fully replaces the old wave. We may infer from Toffler's work that the three waves are definitely progressive, where advancing technologies are the critical variables. Technological revolutions themselves are seen to take place smoothly. The trouble lies within their social milieus, with their social relations and consequences. The fact that technological revolutions are not, and perhaps cannot be absorbed so readily and smoothly as they are produced itself carries the main burden of proof of lack of all-round social progress. For real progress, technological change and its required socio-cultural accompaniments must come simultaneously, rapidly and completely.

Toffler's wave model has many implications for non-Western third world societies going through the ordeal of development through "Westernization", besides the one of not necessarily having to go thorugh the first and second "waves" in order to leapfrog into the third with the most advanced but appropriate technological mixes. The most striking thing in a transitional society like India is that there is a mixture of not just two but three or four "waves", ages or eras simultaneously. These refer to certain stages of techno-industrial development and related socio-cultural organizations and attitudes, not to the proverbial cultural diversity of India. For the sake of convenience, only three stages are identified here:

(1) *Pre-industrial*, characterized by agricultural/rural modes of production and economy; primitive/traditional technologies; family-based occupations and communal or primary relations; past oriented timelessness; ritualism and conservatism; cyclical nature of time/change.

(2) *Industrial*, characterized by machine-based industrial/urban modes of production and economy; formal organizations and professionalism; commercial relations; linear-futuristic perception of time/change; mass media; fast movement.

(3) *Post-industrial* (combining Bell and Toffler's formulations)[3,4], characterized by high speed communication/information, production and service systems; emphasis on mass applications of very advanced technologies; shrinkage of time and space; multidimensional expansion of knowledge and consciousness; highly controlled decentralized systems; very high rate of change.

These characterizations are by no means new, unique or exhaustive. What is unique in India is the fact that they coexist and clash with each other rather disproportionately at the societal, institutional and individual levels. Societally, I would vernture to call 65-70% of India still in the pre-industrial age, 25-30% industrial, and 1-5% post-industrial. These attributions are impressionistic rather than statistical quantities. No single institution

3. *Deniel Bell: Coming of Post-industrial Society: A Venture in Social Forecasting, London, Hienemann, 1974.*

4. *Alvin Toffler: Third Wave, London, William Collins, 1980.*

or individual can be considered entirely post-industrial; but there are many who are exclusively entrenched in the pre-industrial era. Even the most advanced systems, such as space, electronics and nuclear programmes, have large traces left of the industrial and even pre-industrial modes and mentality in maintenance and management. The 25-30% industrial India has to constantly cope with a pre-industrial environment and lack of post-industrial systems and technologies that it should possess and/or have easy access to. Our managerial and technical systems are by and large the products of the industrial age that are often manned and managed by persons of pre-industrial mentality. The clash of eras is most visible in labour's attitude toward time, punctuality, precision, machines and organizational responsibility. Underdeveloped systems of production, maintenance, communication, transport, industrial information and distribution have come in the way of efficiency and growth of firms. Raw materials are procured from rural areas through primitive systems of handling and delivery. Rural labour's lack of education and adjustment to an urban-industrial environment have posed considerable problems in personnel management. Social unrest in the cities, such as religious riots, often causes factory shutdowns and absenteeism. These contradictions are some of the major factors contributing to low rates of productivity in India compared to international standards.

No Indian city is truly urbanized regardless of size and degree of industrialization. Various levels of technology and forms of social organization and attitudes, Eastern and Western modes of living, rural and urban societies coexist and clash with each other in the cities. High-rise buildings have been constructed without proper maintenance and support systems such as water, telephones or elevators. Rural life ridden with poverty hides behind every fashionable shopping or residential complex. From the most primitive to the most modern means of transport ply side by side, maneuvered by people with little traffic sense or traffic rules to follow. Refrigerators, airconditioners, even computers, are delivered by bullock carts. Gas cylinders burst regularly and kill people indiscriminately, because the companies are callous and consumers ignorant or indifferent to safety. Public transport, communications, water, power and sewage systems are either non-existent or only partially functional. Some of these anomalies can be attributed to uneven states of techno-industrial development; others to the related subcultures and attitudes which continue to reinforce the existing state of affairs.

It is intriguing to note how prevalent and deep seated superstition, dogma and rituals are in the tenth largest industrial estate and the fourth largest S&T establishment in the world with close to 4 million highly educated people, including 2 million qualified scientists and engineers. There is not a single Indian, I dare say, even among the most educated, who is truly modern and completely free from pre-industrial mentality. It is a part of being Indian to be superstitious, dogmatic and ritualistic. Or is it part of being human just as well?

Outsiders have often observed with wonderment Indians' apparent facility to live in several different worlds and eras simultaneously, to compromise so many contradictions within the individual personality. It is not uncommon to find prominent scientists who believe in supernatural phenomena; social reformers and preachers who are racists; modernizers and developers who oppose modern medicine and family planning; highly superstitious people who are excellent economic forecasters; or strict brahmins who are leather technologists. How precisely these contradictions affect the totality of science and technology, industry, modernization, change, etc., is not clear. But if India is to ever become a truly industrial or post-industrial society in its own right and in its own peculiar mould, she will have to produce a vision of the future which is consistent and coherent, where the basic premises will be less anomalous, where major philosophical, social and cultural contradictions will either disappear or be cleverly harmonized with the vision. Mass scientific education and a social policy aimed at removal of economic inquality and cultural deprivation will play a critical role in the emergence and realization of this vision.

This lack of clear vision about Indian futures has sometimes led our planners and policy makers in wrong directions. The resulting mismatch between science and technology and human needs and culture has obfuscated general social progress despite the so-called scientific and technological progress. Modernization and development have often brought in their wake large scale destruction of environments in the urban areas, hills, and forests. Displacement of unskilled labour, unemployment, rural to urban migration, and the rural-urban divide have all increased despite, and because of, certain technological, industrial and agricultural advancements. These are well known and amply documented facts which need no further elaboration. We have approximately 25 million unemployed people today next to only 4 million at the end of the First Fiver Year Plan. In 1947, the total literacy in the country was 14%. During the first decade of development, it rose by 14 percentage points, to 28% of the total population in the 1961 census. In the next decade, the rate of increase was reduced by 4% and the 1971 census counted 34% of the population as literate. A decade later, in 1981, the literacy count had risen by a mere 2% to 36% of the population. The relationship between levels of literacy and scientific and technological development may not be obvious, at first sight. But if science, technology and development are to be seen as part of the total process of change — as they should be — in which institutions and individuals play an equally important role — as they should, then it becomes obvious that no society can expect to transform itself without improving the levels and quality of thinking of its people as citizens, people who man and manage institutions, people who generate new ideas and implement them.

SCIENCE AS A COMPONENT OF INDIAN CULTURE WITH SPECIFIC REFERENCE TO THE NATIONAL MOVEMENT

S K Biswas *
S Chatterjee†

It is contended here that science and technology developed in ancient and medieval India as essential components of Indian culture. The development was sometimes vigorous, sometimes lethargic, sometimes along side spiritualism, sometimes in contradiction to it, but all the time contributing to and building up what we call the culture of the Indian civilization. In a recent work entitled 'Studies in History of Science in India' Prof. Debiprasad Chattopadhaya[1] argues the case that the veracity of the scientific dimension of Indian culture has always been a political rather than an academic issue. The time has, therefore, come to take up the issue forcibly in our ideological and political battles for a national resurgence and revolutionary change.

Today, the necessity of the Indian toiling people to regard their life and social environment in a scientific manner is acclaimed by all shades of political opinion, except possibly the extreme right. The bourgois want this to happen, because to them a mass scientific culture is essential for their triumph over feudalism and for consolidating the rule of industrial capital. The progressive political forces realize that for bringing about radical socio-economic changes towards a society governed by scientific norms and laws, a mass consciousness constantly analysing the present material condition and persistently demanding such a change through various forms of struggle is absolutely essential.

What is not in doubt today is the fact that in ancient times, science and technology developed in India as an integral part of Indian culture. Further, one cannot also deny that at present and for certainly hundreds of years in the past, there has been a singular lack of scientific outlook amongst the Indian people to the extent that such a lacuna today has strongly permeated into the citadels of Indian science. This lack of scientific outlook could possibily be traced to the imposed ideological thrust that 'science and scientific methodology has never been a part of Indian culture'.

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Any people at any time in the history of human civilization have looked to their own culture, own traditions and national heritages for ideas, philosophical and social, to understand contemporary reality as well as to overcome multifarious problems and difficulties. If such a culture and national heritage has been deliberately distorted over the centuries to suppress or misrepresent what is scientific and materialistic in that cultural heritage, the culture becomes synonymous with what is unscientific and what one my call in the Indian case as a set of mystico-religious dogmas. The national heritage and culture emerges in modern times as predominantly anti-science. In such a situation, the choice before the people in their search for an understanding of contemporary reality and solutions to contemporary problems are only variations of spirituality. The national culture to which people turn for their identity as people has been reduced to a culture of spiritualism, excluding any reference to the historical development of scientific and materialist trends as integral parts of the same culture, or to a culture where the later traditions are assigned an essentially subservient role. S Radhakrishnan2, an ideologue supreme states in 'An Ideology View of Life' "The western mind lays great stress on science, logic and humanism, Hindu thinkers as a class hold with great conviction that we possess a power more interior than intellect by which we become aware of the real in its intimate individuality..........Institutive realization is the means to soluation ....'He who knows that supreme Brahmin becomes that Brahmin itself'.... While the dominant feature of the Eastern thought is its insistence on creative intuition, the Western systems are generally characterized by a greater adherence to critical intelligence"

While now it is well established in modern philosophical writings that rich and mature scientific thinking had developed in ancient India by materialist, quasi-materialist and metaphysical schools such as the Sankhya, Naya, Vaisesika, Budhist, Jaina, Carvaka and medical practitioners such as the Carkas and Susrutas, we find little reflection of such thoughts in what is known as the essence of Indian culture—spiritualism. The reasons for this glaring exclusion are manifold and complex. Today, there is rapid accumulation of evidence to show that quintessence of the above schools of thought found some popular support in the ancient time and thus threatened the political supremacy of the Brahminical law makers. This brought in sharp struggles between the proponents of the two schools of thought and unleashed a process of careful weeding out of such thoughts from our cultural trends by methods ranging from physical oppression of the materialists to public ridicule of such thoughts, a process which was to last for centuries. All this is now well known. What is however not fully appreciated today is how this distortion of the scientific content of Indian culture made India an easy victim of British colonial ideology. This augmented the hegemony of Indian spiritualists and obscurantists and led to the mass consciousness that science is not and has never been a part of Indian culture.

The crux of the colonial ideology in an overall sense has always been that European culture in all its manifestations is essentially superior to all other cultures and it is therefore the sacred duty of the European races to subjugate other peoples to show them the light. The variation of this theme with regard to science is that science, a process of cognition of nature, has only one origin and that is European. In fact, it is a kind of Greek miracle which resulted in the dawn of science. Prof. Chattopadhaya in the above-mentioned volume writes "Not that the facts of the older civilizations of Egypt and Mesopotamia and in recent years also of Indus—are denied. But these are mentioned cursorily and mainly for the purpose of showing why there could be no real science before the Greeks". Arnold Reymond[3], in 'Science in Greeco-Roman Antiquity', notes, "Compared to the empirical and fragmentary knowledge which the peoples of the East had laboriously gathered together during long centuries, Greek science constitutes a veritable miracle". To continue with the quote from the writings of Prof. Chattopadhaya "After an exciting career of about seven hundred years in Greece, Alexandria and the Greeco-Roman world, science is said to have suffered an eclipse resulting in the darkness of the middle ages. The darkness prevailed over a thousand years. Then there was the illumination of Renaissance Europe when the old Greek tradition was taken up again and conditions were created for the rise of modern science, with an ever-increasing rate of progress since then. This, in brief, is supposed to be the history of science". The essence of the argument is that global science is European science.

What is to be noted here is that this ideological thrust comes to India at a time when the scientific traditions of Indian culture have already been severely distorted and diluted by centuries of Brahminical propaganda against such traditions and the resulting long periods of intellectual stagnation. Thus, when the colonial ideology descends an India, to quote Prof. Chattopadhaya again "for inducing submissiveness among the Asian to the scientifically and technologically superior Western races, i.e. for colonial domination and colonial exploitation" it finds the gound well prepared among the 'natives' who at least in the early stages find little difficulty in submitting to such ideological thrust. There is little doubt today, in the words of Prof. A. Rahman[4], that "the political purpose behind this was to cause a sense of inferiority amongst the Asians and use science and technology as an instrument both of intellectual domination as well as exploitation".

While this is not the place to go into academic refutation of the tall claims of the imperialist ideologies, it may be sufficient to note that modern historical research points to three serious falacies of such an ideology.

Firstly, a number of European scholars in the days before the scheme of global domination started to take roots and therefore not being burdened with the task of propagating imperialist ideology were objective in their

assessment of scientific development outside Europe. They often spoke eloquently not only about the scientific and technological traditions of the East, but also hailed the superiority of such traditions of the European ones in specific branches of science. Secondly, the complete disregard by some European historians of the colonial period to chronological consideration in history fills modern historians of science with a sense of horror and lays bare the ideological compulsions which must have driven these scholars to such grave errors. The histories of trigonometry and chemistry are two such areas from where many examples could be quoted to substantiate this.

Finally, it must be noted that a serious body of research work has been emerging in recent times which points to the complexity and multiplicity of the origin of modern (Renaissance) science and scientific thought in Europe itself. This body of research led by such eminent historians of science as Joseph Needham and Benjamin Farrington puts forward convincing evidence of strong cross-currents of scientific knowledge and thought throughout the world in the later part of the ancient and very definitely in the medieval times. They point to active exchanges of information in the areas of mathematics, medicine, surgery and technology between the Arabs, the Indians, the Chinese and the Europeans. What emerges is a very complex picture of the development of global science, where all these four cultures play equally important, mutually supportive and an essentially comradely role. This research is surely in its infancy and extensive further work needs to be done, especially in the area of 'trade routes' and allied topics to build up an objective picture of the origin of modern science. Whatever work has emerged in this area, however, argues against the concepts of monolithic culture specific origin of science and puts serious doubts on the motives of scholars who once propagated the ideas of the exclusively racial (European) origin of modern science and their modern colleagues who persistently push the ideas of cultural specificity or geospecificity of science.

Here, we have not, of course, touched on the reasons due to which science and scientific thought which had such brilliant starts in ancient India went into a period of acute stagnation subsequently. The reasons are complex, with deep political and economic undertones, and are perhaps not fully understood today. What is, however, of great deal of interest to us today is the fact that in the later period of the British raj, the above-mentioned colonial ideology of science evoked strong resistance amongst Indian scientists and historians of science. To understand this phenomenon, one has to appreciate the deep going political changes taking place in the 19th and early 20th century India. Nineteenth century marked the birth of a national movement in search of an independent identity. The movement manifested in its political dimension as a gigantic anti-imperialist movement to end the British rule in India. The political movement was backed by intellectual and cultural ferment in search of and with the aim to establish an Indian identi-

ty in all aspects of national life. Science and scientific thoughts were no exception of this.

Search for this identity *vis-a-vis* science took two forms. Firstly, there was a revival of interest in our ancient scientific traditions. Considerable amount of work was undertaken at that time by historians of science such as Seal, Mukhopadhaya, P.C. Ray, and others to delve into the ancient texts and to try to establish that science is objectively an integral part of Indian culture. Secondly, a body of opinion started to emerge that as science has deep roots in Indian culture, the national movement must find expression in the development of modern science in India. The most interesting thing about this trend was that the 19th and early 20th century Indian scientific workers, who were passionately and wholeheartedly imbued with the idea of developing modern science in the Indian soil, were deeply proud of their ancient scientific heritage without becoming chauvinists or obscurantists. The contributions of great names such as P.C. Ray, J.C. Bose, C.V. Raman, K.S. Krishnan, D.D. Kosambi, D.M. Bose, M.N. Saha, Visweswarayya and others will not only go down in the annals of human knowledge, but will also be remembered for ever as those which attempted to restore science and scientific thought to the mainstream of our culture.

A singular development arising out of the nationalist movement was the resurgence of science in our society. This trait of Indian culture, which was lost in the previous era and was finally systematically destroyed by the colonial rulers, emerged again through the national movement. The apparently tiny spark which the pioneers like Jagadish Chandra Bose and Prafulla Chandra Ray lit in our society, inspired many a pupil in their times, for they saw in it the glow of hope for the future India. Science to them was not only a profession, but also a penance and a platform for battle against foreign domination The prosperity of future India lay in the removal of its social evils, of which ignorance was one. This understanding appears to have had universal impact on all the leading scientists of the time. Not only were they deeply nationalistic in their attitude, but a few of them, notably P.C. Ray, M.N. Saha and D.D. Kosambi also saw science as a means for social change. In the following, we shall examine the development of the nationalist movement and the role of Indian scientists in the political movements of the time.

An important result of the colonial rule in India was the virtual destruction of the pre-colonial science and technology. However, the necessities of administration forced the East India Company to bring forth Western education to India, with the main intention of training clerks. The idea received considerable support from the wealthier sections of the Indian population, who recognized the possibilities of economic benefit. One of the pioneers in this effort was Raja Ram Mohan Roy, who cherished a deep admiration for the liberal movements in Europe. An extraordinary social

reformer, who was deeply inspired by the Vedic culture, Raja Ram Mohan Roy evaluated the impact of the social changes in Europe as a liberating force on the decadent Indian society. The economic policy of the East India Company and the subsequent introduction of Western education gave rise to a class of intellectual elite who also formed the rising bourgois in the Indian society. In the initial stages, i.e. till the middle of the 19th century, this class acted as an ally of the British rulers. Nevertheless, this rising bourgois ultimately became the champion of the nationalist movement in India and their ideology contributed in a big way to the resurgence of science in the Indian society.

The emergence of modern science in India was not an immediate consequence of the introduction of Western education. In fact, many British officials undertook sustained exploration of the resources of India. These researches were carried out more in the form of personal projects rather than directed enterprises of the East India Company. Although the absence of official patronage was an obvious hindrance to research, these initial endeavours were of immense importance in initiating the process of development of science. The scientific work of the time covered exploration of flora and fauna of India, survey of land, meteorology, geological survey, etc. Medical services were organized quite early, i.e. in 1763, in British India, though the first medical college began its operation in 1835 at Calcutta. Medical research as an organized branch of scientific activity appeared much later and considerable success was recorded by such eminent research workers as Haffkine, Upendranath Brahmachari and the illustrious Ronald Ross. Research in India, in any branch of science, was beset with innumerable difficulties, of which lack of funds was the major one, e.g. Haffkine began his work on plague in a one-room laboratory in Bombay, and had only a clerk and a peon to assist him[5].

Though the first universities in India were started in 1857 (i.e. hundred years after the battle of Plassey), science education was left in a state of neglect. With reference to scientific research, the only fields that received attention (no matter how meagre) were those of public health and agriculture. A few engineering colleges were also opened in different parts of the country to cater to the needs of the public services. Fundamental sciences were thought to be irrelevant by the colonial policy makers. It thus comes as a great surprise that the major achievements of Indian scientists in the British era lay precisely in the area of fundamental sciences. So outstanding were their contributions that the world of science, dominated by the West had to accept the claims of India. 'Western science' could thus no longer remain a monopoly of the West[6].

In this process of development, the roles of Sir J.C. Bose and P.C. Ray are of singular importance. The subsequent stage of intense scientific activity that appeared in the early 20th century, owes its origin considerably to the pioneering efforts of these two men. In the absence of funds,

and trained collaborators, research for Bose was an act of penance. His intellectual talent was discovered very early in his student-hood by the illustrious physicist, Lord Rayleigh, and Bose returned to India in 1885 having been offered the position of Assistant Professor at the Presidency College, Calcutta. The existing laws of the time did not entitle an Indian to the "full salary" that was given to a British professor. In spite of this humiliation, Bose accepted the offer, but as a mark of protest, he refused to draw his salary until the discrimination was removed. The immense hurdles that scientific research faced would have curbed the enthusiasm of lesser individuals but not Bose. Through his painstaking efforts, which often curbed his personal savings, Bose produced in 1895 his first wireless device and demonstrated his results at the Calcutta Town Hall. Publication of his results won Bose immediate acclaim from no less a body than the Royal Society of London and he was invited to deliver lectures at the science institutes of England. Though considered as a physicist of outstanding merit, it is believed that Bose's claim as the first inventor of the wireless was ignored because of his Indian origin. In the later part of his life, Sir J.C. Bose devoted his energies to the study of response of turning bodies to electrical perturbations. His discoveries in this area are considered as landmarks in the field of biology, which proved that electrical impulses do not distinguish between the living and the non-living or in terms of our modern understanding living bodies are in fact non-living in their fundamental composition. The relationship between life and matter remained a life-long search for Sir J.C. Bose. The Bose Institute of Science founded by him remains a testimony to his untiring zeal for the promotion of science.

It is generally considered that it was in the late 19th century that science in India came of age. The pioneering efforts of Prof. P.C. Ray, a contemporary of Jagadish Chandra, can hardly be overestimated. Recognized as a brilliant chemist and a man of deep nationalist conviction, Prof. P.C. Ray not only directed his energies for the establishment of scientific research, but he was also a prominent crusader in the national movement and a champion for the cause of industrial development of the country. His deep sense of patriotism is reflected even in the earlier writings that he produced during his student days at Edinburgh. His "Essay on India", though "bearing marks of rare excellence", was suppressed by the Scottish press because of his "bitter diatribes against the British rule". In reality, however, the essay was a critical evaluation of the British rule in India. Thus, while admitting "the part played by England in the furtherance of the intellectual progress of the Indians", the essay recorded how England "refuses to recognize the hard and irresistible logic of facts and does her best to strangle and smother the nascent aspirations of a rising nationality". In recognition of the "cruel exigencies of an alien rule", Prof. P.C. Ray made a moving appeal to the "rising generation of Great Britain and Ireland............for a humane policy towards India". "The disillusionment" was, however, "not long in coming".

The inevitable realization that "there is not in the history of the world a single instance of the dominant race granting concession to a subject people of its own free will and accord" drove Prof. P.C. Ray to the anti-imperialist movement of the time. Science to him was not a mere profession, it has also opened up many frontiers of battle[6].

For a chemist of extraordinary calibre as Prof. P.C. Ray was, the frontiers of research were indeed numerous, whether it meant the discovery of mercurous nitrite or investigations on the minerals of India. The glory of a scientific profession was also linked with the emancipation of the people; in this respect, the work on isolation of food adulterants was as much a part of fundamental chemistry as the understanding of the Mendeleév table. A person with deep sensitivity to social affairs, Prof. P.C. Ray could not rest contented merely with his laboratory work. The work initiated by him should not disappear with his passing. With his untiring zeal and inspiring guidance, he built a flourishing school of chemistry with such illustrious pupils as J.C. Ghosh, J.N. Mukherjee, N.R. Dhar, P.B. Sarkar and J.N. Rakshit. Simultaneously, his work on the history of Hindu chemistry is a work of immense importance, which establishes the existence of a rich scientific culture in ancient India. With the establishment of the Bengal Chemicals in the early 20th century, Prof. P.C. Ray became a pioneer in the chemical and pharmaceutical industries in India. This was in fact meant to be an act of challenge against the economic drain of India, a concept which was so eloquently expressed by Dadabhai Nauroji. Successive stages of his life saw P.C. Ray enter into higher levels of public involvement in which science got merged with his social life. Though recognized as a "great savant of chemistry" by no less an authority than the world renowned M. Berthelot, Prof. P.C. Ray was also a close collaborator of Gokhale and Gandhiji in the anti-colonial movement. The great enthusiasm that Sir J.C. Bose and P.C. Ray had created at the time influenced Tagore to write to Sir J.C., "you must see that the flame of knowledge that burns in you remains alight in this land of India,................Once again, if we are to hold our heads high we must ascend the teacher's dais. You must erect that dais, you must mount it[7]. This message of inspiration, though addressed to Sir J.C., actually belongs to the era and the spirit of national reawakening which Sir J.C., P.C Ray and Tagore created.

The resurgence of science, which Sir J.C. and P.C. Ray led, developed into a more organized scientific activity with the opening of the University College of Science in Calcutta. The founder of the institution, Sir Ashutosh Mukherjee, himself a mathematician of some talent, engaged the most dedicated scientific workers of the time, to serve in this institution. Megh Nad Saha and S.N. Bose were given the task of teaching theoretical physics, while K.S. Krishnan and the illustrious C.V.Raman concentrated their attention on experimental research, specially on light scattering. Side by side, the Indian Association for the Cultivation of Science, a research organiza-

tion founded by Dr. Mahendralal Sarkar in 1876, also appeared as a centre for intense scientific activity. In describing the tremendous promise that science in India held, Ziman has noted later, "one might quite reasonably, have regarded Calcutta, Madras, Lahore and Bangalore as embryo Harvards and Gotingens for an immediate renaissance of Indian scientific culture".

Of the great contribution that emerged at the time, the work of Sir C.V. Raman certainly comes first to our mind, not merely because of the Nobel Prize, but also because he put the culture of experimental science on a firm footing in India, in spite of the absence of a supporting infrastructure. So great was the impact of C.V. Raman's contributions that Prof. P.C. Ray wrote, even before the award of the Nobel Prize, "My young colleague, Prof. Raman, is a host in himself. Suffice it to say that if this temple of science had produced only a Raman and nothing else, it would have amply justified the high expectation formed by its founder". Though best known for his discovery of the Raman effect, Raman has in fact many discoveries to his credit like the Raman-Nath effect; the concept of mode softening, which is so extensively used in solid state physics today was in fact an original discovery of C.V. Raman. His worthy colleague, Sir K.S. Krishnan, is regarded as a symbol of highest understanding. His experimental work on magnetic susceptibility, work function of metals and theoretical work on electrical resistance of metals are outstanding contributions to the field of science. A man of deep nationalist convictions, K.S. Krishnan became the first director of the National Physical Laboratory, Delhi.

In the field of theoretical physics, S.N. Bose and M.N. Saha acquired positions of prominence. In the absence of sutable literature, the two young men faced immense hardship to keep themselves abreast of the recent scientific advances. The two were self-taught theoretical physicists. Their contributions remain as landmarks in the field of science. The work of M.N. Saha on thermal ionization brought him immediate recognition; in the words of the famous astrophysicist, Prof. Rosseland, "the impetus given to astrophysics by Saha's work can scarcely be overestimated, as nearly all later progress in the field has been influenced by it and much of the subsequent work has the character of refinement of Saha's ideas.

And today, Saha's work on magnetic monopoles, which appeared in the 1930s, has evoked considerable interest in the field of elementary particle physics. Bose's epoch-making work appeared in 1925. Its importance was first recongnized by Einstein while the first idea about applying quantum statistics to radiation emerged through a discussion with Saha in 1924. Analysing the importance of Bose's discovery, Prof. John Bardeen remarked fifty years later, "Bose's name will live as a part of the world of physics for all times to come and Bosons will be with us for ever"[9]

The social commitments of these two men drove them to different spheres of activity. While Saha was a vocal spokesman for radical social change, S.N. Bose concentrated his attention on the promotion of science

education through mother tongue. This remained his life-long mission, which had even inspired the poet Tagore to write a science treatise entitled "The picture of the Universe" and dedicate the work to S.N. Bose. Saha's involvement with political movement goes way back to his school days, when he was expelled from the school because of his association with a protest demonstration against the British rule. At a later stage in his life, Saha combined his efforts with those of Sir P.C. Ray in organizing relief for the victims of flood in Bengal. Later still in the thirties, he invited the experts of the Tenessee river project to study the conditions of Indian rivers and suggest solutions to the problems of recurrent floods. Saha can rightly be called the architect of the Damodar Valley Corporation. Saha's main contribution in public life lies in bringing the message of scientific advance to the more radical section of the antiimperialist movement. It was mainly through the work of Saha, Subhash Chandra Bose and Jawaharlal Nehru that a commission on science and technology was formed by the Indian National Congress in 1935. Perhaps this is a direct evidence for Prof. Bernal's assertion that the forces of scientific development in India were the masses behind the nationalist movement. It is certainly no exaggeration to suggest that in India's thrust to scientific modernization, the fundamental groundwork was laid by Saha in the preindependence days. He is also considered to be the founder of research on nuclear physics in India. Saha's visits to the Soviet Union had a tremendous impact on his understanding of social questions[10] His shift towards socialist ideas was quite perceptible in his actions, both as a science policy expert and as an opposition parliamentarian. Saha remained true to this ideology.

The pattern of development of science in India, as described in the foregoing paragraphs, shows close links between the development of science in colonial India and the national movement against the British rule. The pattern of growth is seen to follow the same form as is found in other societies, i.e. stages of great social changes are also the periods of great discoveries in science. A significant fact that is unmistakably revealed is that the post-renaissance science that developed in Europe also took deep foundation in India and the contributions of the great Indian scientists have formed an integral part of the world body of scientific culture. This cumulative body of knowledge that derives its source from the development of knowledge from different societies is thus too universal to suggest a geo-cultural specificity of science.

No disussion of India's scientific progress is, however, complete without a study of the advances in the field of social science. In this area, the work by D.D. Kosambi occupies a place of great prominence. A mathematician by training, Kosambi combined the analytical methods of a mathematician with his keen observational powers in deriving astounding results in such diverse branches as statistics, genetics, path geometry, history, linguistics, politics and so on. While Kosambi is universally acknowledged

as a pioneer in the study of history, in mathematics too his fame was unchallenged. Recognition came to him from several reputed organizations of mathematics, like the Soviet Academy of Sciences, and the Institute of Advanced Study in Princeton, U.S.A., where he participated in several technical discussions with Einstein on the unified field theory. The mark of a rare versatility can be discerned from Kosambi's researches in mathematics, for they cover such wide topics as path geometry,theory of numbers, theoretical and applied statistics with applications to the Indian population problems and genetics. The Kosambi formula on the map distance of genes remains an important discovery in the field of genetics and statistics. It related the fraction of genes that cross themselves to the separation of genes on the chromosome. This work obtained immediate recognition as excellent refinement over the previously derived Haldane formula.

Deep social commitment and meticulous care to understand the complexities of the society are readily identified in Kosambi's works. Large portions of his works in statistics deal with the Indian population problem and the optimization of foodgrain production. Kosambi was invited by the Chinese Academy of Sciences to advise the government on similar problems. Yet Another of his recommendations when implemented by the corporation of Bombay brought down the incidence of cholera in the city. From the study of ancient trade-routes of the Deccan, Kosambi made several valuable suggestions to the government, so that more number of villages could be connected on the route. As ardent crusader for social justice, Kosambi had close links with the revolutionary movement of the country. A champion for the emancipation of mankind, Kosambi emerged as one of the prominent leaders of the World Peace Movement. This particular point deserves special mention, as India's position in the world is to be viewed today in terms of the global situation.

The greatest achievement of Kosambi lies in the introduction of a scientific methodology for the study of Indian history. The unsatisfactory attempts to build a history of India from the poor documentations contained in the religious books, or in the popular myths, led to the lighthearted sneer, "India has had some episodes, but no history". Side by side, one observes the obscurantist effort to take our country back in history propagating the myth of a "Golden Age" in the past. Kosambi saw both these distortions of history as a means of obscuring the truth. "Its (history's) importance lies not only in the interpretation of the past, but as a guide to future action. By its correct use, men can make their own history consciously rather than suffer it to be made as helpless spectators". It was thus necessary to "reconstruct a history without episodes" and present it as "a chronological order of successive changes in the means and relations of production". He recognized the tractability of our past and also established that "there was no original golden age of mankind outside the imagination of poets and priests. The golden age, if any, lies in the future".

It is clear from the above that Kosambi followed the method of dielectical materialism, as enunciated by the validity of a class basis in historical research. The primitive pattern of class division was discerned by Kosambi ih the caste system, which with its immense flexibility provided the means so that, "The older cults and forms were not demolished by force but assimilated. The process was of crucial importance in the history of India , first in developing the country from tribe to society and then holding it back, bogged down in the filthy swamp of superstition". This trait of assimilation is brilliantly illustrated by Kosmbi in the development and survival of the Krishna cult, where the Gita, "with its brilliant Sanskrit and superb inconsistency justifies almost any action while shrugging off the consequences". Likewise, the Arthashastras "the Machiavelian description of the Magadha state (180-160 BC)" describes how the institution of a complete police state could be adapted to the tenets of buddhism".

As in the case of history, the method of dialectical materialism was the basic philosophy for Kosambi to explain the evolution of science. Thus, to use the off-quoted definition of Kosambi "Science is the cognition of necessity, ...science is the history of science"' It is no surprise therefore that the great upheavals of science set forth tremendous changes in the social relations, which, in turn, determine the path of scientific progress. So, it is a gross misconception to work under the illusion of a 'free science', unrelated to the social relations. Stagnant social relations hold back the progress of science. Modern science, which once liberated mankind from feudal rule, has grown into a "theology of the bourgoisie" in the hands of capitalists. Thus, the urgent task of the hour is to liberate knowledge from its artificial fetters and examine history in order to change it.

REFERENCES

1. *Chattopadhyaya, Debiprasad: Studies in the History of Science in India, Vol.I & II. Editorial Enterprises, New Delhi, 1982.*

2. *Radhakrishnan, S: An Idealist View of Life. Hibbert Lectures. London, 1937.*

3. *Reymond, A: Science in Greeco-Raman Antiquity, quoted by B. Farrington, Greek Science. Pelican, 1963.*

4. *Rahman, A: Introduction to Science and Technology in Medieval India (under publication)*

5. *Subbarayappa, B.V. & Das Amita : in Science and Society, Ed. A. Rahman and P.N. Chowdhary, Centre of R & D Management, C.S.I.R., New Delhi, 1980.*

6. *Ray, Prafulla Chandra : Life and Experiences of a Bengali Chemist, Chuckervertty and Chattejee, Calcutta, 1932.*

7. *Khandkar, G.D.: The Lute and the Plough, The Book Centre P A Ltd., Bombay, 1963.*

8. *Ziman, John: The Force of Knowledge, Cambridge University Press, 1976.*

9. *Bardeen, John: in Frontiers of Theoretical Physics, Ed. F.C. Auluck, L.S. Kothari, V.S. Nanda, The Macmillan Co. of India Ltd., 1978.*

10. *Saha, M.N.: in Lenin, His Image in India, Ed. D. Kaushi, and L. Mitrokhin, Vikas Publications, 1970.*

SCIENCE AND SOCIAL HARMONY: THE NEED FOR SWADESHI SCIENCE MOVEMENT

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1. SCIENCE AND TECHNOLOGY — THE ORGANIC LINKAGE

There are many who believe that science is universal and international, neutral and value-free, secular and culture-free, etc. In its purest form of exposition of truth, it may be so, but science is always organically linked with technology, mutually promotive and interdependent. Under these conditions, science can never be neutral, value-free or culture-free, because technology is the base of industrialization, economic activity and even socio-political sustenance. One cannot, therefore, deal with science in isolation; science always connotes technology and vice versa, and thus affects all social activity.

2. SCIENCE AND SOCIAL HARMONY

It is from this angle that we have to analyse the way science affects social harmony. Social harmony has many dimensions, but it depends very much on the individual and his interactions with society and nature. To a very large extent, the harmony within man depends on the physical, mental and spiritual attributes and all these depend on the social-cultural-economic-political milieu of a nation. Social harmony thus has all these domains, and, therefore, science and social harmony are interrrelated. Thus, there arises the impossibility of viewing science in isolation, and the need for relating it continuously to national culture and the social-economic-political system. It is naive to imagine that science can be viewed as a secular activity, indifferent to the history, the culture and the social framework of the nation. It is in this respect that we need a Swadeshi Science Movement.

3. A NEW SOCIAL ORDER

Before the advent of the era of modern science, the society the world over was under a religious order — in the west under Christianity, in the middle

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east under Islam, in China, Japan and much of the Far East under Buddhism, in India under Hinduism, etc. With the rapid development of modern science, as we know it today, there were occasional conflicts between the tenets held supreme by the organized religions and those discovered by the science in the west. But the essential characteristics of the Indian culture have always been tolerance towards other faiths, inclusive of scientific faith, and a capacity for adoption, adaptation, assimilation and absorption of all that is good from whichever quarter it comes.

But the deep-rooted cultural heritage of India allowed this process to be evolutionary and slow, rather than revolutionary and abrupt. This process is still going on at its usual slow pace in India, even though many would like to see an instantaneous uprooting of the existing culture and installation of alien cultures — in science and technology, in the gigantomania of industrialism and an economic policy of growth based on such industrial developments, in modifying the political concepts of equality and democracy to suit this objective, or in undermining the abiding faith in spirituality in the name of science branding spirituality as religious obscurantism or revivalism.

In the west, on the other hand, the developments in science and technology and the captivating material comforts thereat and thereof overshot the cultural and religious base; in the past two or three decades, there has been an apparent awakening among many intellectuals against the dangers of such a process. This voice mostly comes from the open democratic societies of the world, in spite of the stranglehold of military-industrial monopolies. What little comes out from the other side of the iron curtain also points to the same conclusion, viz. the "science culture", to put it briefly, has displaced much of "spiritual culture", and this has aggravated many of the social problems. What is needed, therefore, is an altogether new social order. Throughout India, in fact throughout the world, an intense discussion is currently going on on the relevance of spirituality in this era of modern science — in other words, on the need for a synthesis of science with spirituality and for an integration of science with national culture.

Unfortunately, a country like India, which retains the oldest spiritual culture of the world and is expected to play a leading role in this endeavour, is facing a grave crisis of confidence now. All sensible terms are corrupted to the core by vested interests of the so-called "progressive internationalists" in such a way as to brainwash the intellectuals and mislead the illiterates towards a unidirectional thinking, projected as a panacea for all the ills of the society. "Secularism" is, for example, made to mean anti-spiritual and antireligious, and not to be understood in its real sense of equal concern for all honest religious practices. "Scientific thinking", so essential for developing creative abilities, objective analysis, logical conclusions, verifiability and repeatability, is projected as "nationalism" and "materialism", all directed towards atheism, anti-spiritualism and anti-religionism. Instead

of taking corrective steps for any aberrations in culture and religion, as has been done by many spiritual reformers from time to time, "scientific temper" is invoked, not to instil faith in science, but to demolish faith in national culture and spirituality.

4. A CRITIQUE OF SCIENTIFIC TEMPER

The trend in this type of negative thinking was set in motion by the Statement on Scientific Temper from Nehru Centre in November 1980. Nationwide debate is now going on against this document, and it is heartening to note that this tempo is catching up with such a vigour and vitality that few can ignore the saner side of the fact trying to evolve a new social order with a sustainable ideology which integrates science with spirituality and brings about social harmony in its broadest sense. There is no conflict between science and spirituality, but conflict arises when science or spirituality degenerates to dogmas. Our most important and immediate concern should be that these debates do not remain at the ideological bla-bla level alone, but would direct attention towards an analysis of the problems of the country in its totality in order to see how best science and technology could bring about social prosperity with freedom and social harmony. It is here that we identify the need for a Swadeshi Science Movement. It is silly to conclude that India does not produce Nobel Laureates because of the lack of the so-called "scientific temper". What India needs is good science to serve the people and not a Nobel prize in the graveyard of starving millions.

5. SPIRITUALITY AS A FOUNDATION FOR MORALITY, EQUALITY AND ECONOMIC-POLITICAL IDEOLOGY

Spirituality is the cultural and philosophic base of India and to a large extent the basis for ethics and morality all over the world. Spirituality has its origin in the obvious recognition of the existence of a soul, a spirit in man, as distinct from matter. Rationalists and materialists do not recognize the independent existence of spirit, and all human behaviour is attributed to matter and material properties.

Let us analyse the question a little further. As we move from the inanimate matter in minerals to plants, from plants to animals, and from animals to man, there is something extraordinary happening, something extramaterial appearing, something wonderful manifesting itself — awareness, consciousness, intellect, love and compassion, and all that. This we take as the manifestation of 'soul' in man, as distinct from lack of it in minerals. If such a spirit exists in man, it should have its origin somewhere, as science demands; it should come from somewhere, from something — that 'something', that 'somewhere' is God, in common parlance. Unfortunately, "fashions", "progressive outlooks", and "scientific temper" demand that it

is below the status of a scientist to speak of "soul" or God — all unnecessary in this productive, utilitarian world.

According to Vedanta, if the soul of man is "Jeevatma", God is 'Paramatma', and Jeevatma is a manifestation of Paramatma, also called Brahman. Indian seers and philosophers further realized that the origin of all matter is also Brahman. Brahman only existed at the beginning; and at a certain stage, Brahman manifested itself as matter, then manifested itself as 'Prana' or soul in matter, the highest manifestation being in man.

Indian Yogasastra (the science of yoga) enumerates the ways of "attuning" the physical - biological and the mental - psychological processes in man in order to be in tune or harmony with the cosmic vibrations of 'Brahman'. This is "spiritual realization", the revelation of eternal truth of unity in the diversity of world. This revelation leads to the understanding that the same spirit resides in all fellow beings, the whole multitude of universe being a manifestation of that unity called Brahman. If we can believe that the whole matter can be converted into energy and vice-versa as scientific truth ($E=mc^2$), we have a parallelism in the Brahman-matter-soul manifestation. This simple realization is the basis for what is called spirituality, and spirituality is the basis for love and compassion, ethics and morality, equality and fraternity, and even secularism and democracy.

The Karma theory, the theory of rebirths, the theory of incarnations or avatars, the existence of miracles, and the possibility of transmigration, telepathy, ESP, faith healing, efficacy of prayer, etc., all these have their origin in this spirituality. Indian religions and Indian culture are profoundly influenced by the concept of spirituality. There is, of course, a need to subject spiritual concepts such as the above to modern scientific analysis, as has been done with yoga and meditation.

Materialists deny the existence of spirit and take matter as the only reality. What we call the manifestation of the divine in man, the soul or life force, is just a molecular property according to the materialists. If this is accepted, the whole basis of ethics and morality is lost; the whole philosophical foundation of social equality and universal brotherhood is lost. Why should we be good and do good, why should thou love thy neighbour as thyself, why should I become a democrat; why should I not become an exploiter? Without the firm foundation of spirituality, one cannot become a true democrat, nor does one find any reason to be good or to be faithful to his group or to make sacrifice for the sake of others. Pure materialistic concept fails on all these fronts.

Moreover, if the soul of man is just a material or molecular property, as the materialists seem to believe and attempt to make us believe, one fails to understand why no materialistic scientist ever attempted to study this property. So much has been done on chemical, physical, mechanical, electrical, electronics, magnetic or optical properties of materials — the so-called atomic and molecular properties — but no serious attempt has ever been

made to develop a "spiritual property" in materials, while at the same time, a materialistic dogma is created in this respect. The fact is that matter is a manifestation of spirit and spirit is the only reality; Brahman is the only reality, as Vedanta asserts.

It is a pity that our modern world which talks so much about equality, democratic socialism or communism paid no heed to the fact that these assertions have no roots in materialism. Pure materialistic concept of humanity cannot logically talk about equality and fraternity. That part of materialism which stresses on material welfare of all is definitely welcome, but no political or economic philosophy can rightfully claim the ideals of equality or fraternity or even the end of exploitation so long as it does not enter into the domain of spirituality. Spirituality alone can tell us that we all are essentially one. One spirit is appearing different due to our ignorance and inability to peep into the bottom of reality. So long as we do not produce spiritual leaders, we cannot hope to get true liberty, justice or peace in society, And this is the true picture of what prevails in all the so-called democratic or socialistic societies, whether they be free and open or closed and totalitarian.

Spiritual ideal does not mean any narrow sectarian idea. It only implies that the leaders must be taught the oneness of humanity as preached by spirituality of Vedanta. Scientists must imbibe the ideal of humanism. As Albert Einstein put it: "caring for man and his destiny must always constitute the principal interest of all technical efforts. Never forget that in the midst of your diagrams and equations". The desire for the well-being of one and all comes from the conviction that there is no distinction between one individual and the others. Our materialistic declaration, howsoever lofty it may be, lacks the unifying foundation and contains the latent elements of corruption and exploitation at every level. Our scientific achievements shall be useless unless we learn to live in a brotherly spirit with the rest of the humanity; at the practical, operational and application level, science has degenerated itself into an instrument of exploitation (industrially and militarily) and needs the corrective touch of spirituality. Science and spirituality should flourish together and nourish each other; science and culture should coexist and nurture each other; and science and religion should correct each other, bereft of dogma, and direct the mankind to freedom and social harmony.

We may conclude this in the way Swami Vivekananda would have concluded: Spirituality recognizes the existence of an atma or soul in man. Each soul is potentially divine. The goal of spirituality is to manifest this divine within by controlling nature, 'external' and 'internal'. This harmony within man and between man and nature alone brings about the needed happiness. We can realize this harmony by work (Karmayoga), worship (Bhaktiyoga), psychic control (Rajayoga), and/or philosophy (Jnanayoga) — by one, or more, and be free. This is the meaning of true religion based on

spirituality. Doctrines and dogmas, scriptures and rituals, temples and forms, are but secondary details. Material welfare is a prerequisite to this spiritual pursuit, and is as important as spiritual attainment. While science is the means to attain material needs, science and spirituality should go together for perfect harmony and happiness of mankind.

6. SCIENCE IN ANCIENT INDIA

Throughout Indian history, there has been an intimate integration of science and spirituality. The Indian mind has ever sought to know the inner spiritual truth and the outer physical laws of nature in all shades of human activity. Everything useful to life or stimulating to mind — phiolosophy and theology, logic and grammar, rhetoric and language, script and sculpture, dance and music, medicine and astronomy, in fact all arts and sciences — had been an object of intense inquiry, critical analysis, personal experience, and even experimental verification. This unbroken tradition of excellence continued until the colonial era. Standing testimony to these are : Ayurveda as a perfect system of medical sciences; yoga as a perfect system of exercise and meditation; the urban planning for perfection as seen in Harappa or Lothal; the Ajanta - Ellora - Elephanta -Bagh caves; the multitude of marvellous temples; and even such modern wonders like the rustless Iron Pillar of Delhi of the 4th century or the Taj Mahal of the 17th century. An India which can develop such marvels before the advent of modern science and technology cannot be said to have been backward in science and technology by any stretch of imagination. But this leadership in all facets of art and sciences was lost or destroyed in the colonial era, and now is the time to rebuild India with modern science under her own cultural milieu, accepting what is good and rejecting what is patently bad. This is the philosophy of the Swadeshi Science Movement.

7. THE TWO FACES OF MODERN SCIENCE

There is no doubt that we are living in a new form of technological society. Modern life is an epitome of the marvels of scientific developments, which, in turn, have brought about dramatic changes in our life styles, in the way we eat, drink, travel, work, play, entertain or sleep, and in our thinking and behaviour patterns. Science and technology have now become the major instruments of economic and even social and cultural changes.

With all these outward manifestations of benefits and utility, we cannot deny the other fact that modern science and technology are solely, wholly and fully responsible for some of the worst problems of humanity as well, viz.,

(a) the possibility of total annihilation by atomic warfare;
(b) the continuous environmental decay due to pollution,
(c) the onslaught on spirituality by the irrational materialists in the dignified garb of science,
(d) the expensive gigantomania in space explorations and defence "deterrence", maintaining at the same time an arrogant unconcern for the suffering and starving millions, and
(e) conspicuous consumption of resources, and the uncontrolled consumerism and industrialism.

This process has inevitably resulted in the destruction of the most cherished equanimity in man and the harmony between man and nature. The Indian sciences had always tried to preserve an integrated approach to truth and knowledge. Spirituality, philosophy, science and technology were all an integral part of religion. And any aberration in any aspect of Indian culture has itself been corrected by a Buddha or a Mahavira, Sankara or a Vivekananda, an Ashoka or a Mahatma Gandhi, and all these had been within the cultural heritage of India. Limiting our material wants is an essential element of human happiness, but the modern western trend in the industrial-consumer society is (a) to set sky as the limit of material wants and (b) to be unconcerned with spirituality, both of which lead more to unhappiness than to peace.

8. THE DANGER OF APING THE WEST

It is but natural that people everywhere have the same aspirations for comforts and convenience or for health and prosperity. A minimum level of material comforts, especially in food and shelter, is certainly the basic ingredient of a higher quality of life, and ought to be ensured to everybody so as to enable him to seek his spiritual pursuits. In order to achieve this, science and technology are naturally tied to economic growth.

But the trouble with us in independent India was that we did not know where to start and how to get started. It seemed only natural to adopt western economic theories and use western technology and western concepts of large-scale, mass production industrialization, since those seemed to have worked well in western countries, capitalist as well as communist. Gandhism, in spite of all its simplicity and time-tested authenticity under the cultural ethos of the country, was thrown into the dustbin of political expediency, and capitalism and communism with their imperialistic industrialism were given a place of pride, acceptability and respectability. This created a queer desire to ape the west, capitalist or communist, in every sphere of activity, always running after a mirage of elusive economic goals. Materialism was masqueraded as the scientific means for material prosperity.

The elusive nature of our goals and objectives would be clear when we compare India with a developed western country in terms of per capita

consumptions. We are far, far behind in this ladder of development. In defence alone on this standard, we have to raise annual expenditure from the present Rs.5000 crores to about Rs.500,000 crores, which alone is more than 5 times our Sixth Plan provisions or 15 times our annual central budget. And still we will have the doubts: What for all these? The increase in GNP of USA in one year equals the increase that India may hope to be able to manage in about 100 years.

Item	Per Capita-Approximate		Increase required
	Developed Country	India	
GNP, $	6000 (typical)	100	60 times
Steel, kg	470 (typical)	14	33 "
Metals, $	88 (typical)	7.7	11 "
Electricity, kWh	10000 (USA)	160	62 "
All energy, kg (coal eq)	11000 (USA)	220	58 "
Cement, kg	700 (typical)	28	25 "
Fossil fuel, $	65 (typical)	7.7	9 "
Military expenses, $	800 (typical)	8	100 "

In 1980, USA produced about 3 trillion kWh of electricity for its 224 million population. Can India with 700 million population ever hope to reach that level? Is it necessary? Is this the path of development that we should adopt? Is there an alternative to this type of a technological society? Has Gandhism any relevance to India?

9. AN ALTERNATIVE STRATEGY

While it is true that we have a right to aspire for a better way and quality of life as in the west, the implications of using western technology for achieving such a level of material prosperity create a serious predicament — impossibility, impracticability, and above all utter futility. The Indian culture stipulates that happiness can best be achieved not by expanding our material wants but by limiting them to acceptable levels of requirements. After all, there are limitations in our natural resources on which we depend for our food, energy and other basic material needs. Our approach should be to maximize production and productivity of renewable resources, and to minimize, conserve and recycle non-renewable resources. This would require a new form of technology and economic theory.

The western concepts of development based primarily on economic growth and its one-to-one suitability to India is to be seriously questioned. We need not seek science and technology exclusively for high growth rates in GNP, regardless of how best that growth is equitably distributed, or whether such growth is desirable at all, or whether it is not detrimental to the inner harmony in man and in nature. Wealth and material possessions apart, what man needs most is a conducive cultural, social, psychological and even economic and political atmosphere where his individual freedom is honoured — freedom from poverty, freedom from exploitation and freedom to uphold his cherished cultural heritage and democratic right. What we seek is a cultural form of spiritual egalitarianism. Material prosperity should foster harmony in man and between man and nature.

10. IMMEDIATE PRIORITIES

As a first step, our new strategy on science and technology should embody a direct attack on mass poverty and under-employment, a far greater degree of self-reliance and self-sufficiency, and a sincere practice of moderation. In the new approach, national production targets and development efforts should first aim at meeting the basic needs of the rural poor, especially with respect to a progressive reduction and eventual elimination of malnutrition and disease, illiteracy and unemployment. This reflects a shift of emphasis on the use of science and technology more for social than for economic development.

This calls for science and technology to be closely interwoven with individual initiative and enterprise, which requires a new socio-economic-political ideology. Development under global capitalism (uncontrolled individual initiative to the point of extensive exploitation) is more or less a misdevelopment, while that under the existing form of global socialism (uncontrolled exploitation by the state to the point of individual lithargy) is a maldevelopment, both being based on military-industrial imperialism, crazy consumerism, gigantomania, and rationalistic-materialistic thrusts under the pious guise of science. The new approach would have its roots in our own cultural and spiritual milieu leaning heavily on what has been initiated by Mahatma Gandhi and what may be termed as Dialectical Spiritualism.

Our first concern in this Swadeshi Science Movement would be to feed the growing population, shelter them, clothe them, educate them, employ them, and engage them in positive vocations. The development of human resources is at least as important as the development of natural resources. The ultimate decisions on developmental strategy are, of course, made by the people in power or people with power. We would be better off if they too are imbued with a feeling of social responsibility and a concern for social harmony. This brings out the importance of popularization of

science among the masses. What we need is science and spirituality together, not the crude materialism-rationalism combine in the name of scientific temper. The future science education programme should be geared to draw its inspiration and sustenance from the ethos of integrated scientific and spiritual achievements of ancient India.

In this endeavour towards a Swadeshi Science Movement, science would not be allowed to become another "opium of the masses", nor would scientific temper be allowed to become the amphetamine of the intellectuals. Science and technology would, instead, be harmoniously blended with spirituality and integrated with man, nature and culture, leading to a perfect harmony within man and between man and nature.

Thw Swadeshi Science Movement should draw up a concrete framework of science and social harmony: what can science contribute towards social harmony; what precisely are the problems of the country and how best and how far can science be used to solve them; and what has been the nature of problems which science itself has created through its technology, industrialization, militarization, consumerization, and a myriad of its own dogmas?

We should recognize that the spiritual is not a negation but an extension and refinement of the material, and the supernatural is not a negation but an extension and refinement of the natural. There is a need for meditation and prayer for spiritual development and tranquility, and yoga and exercise for physical development and vitality, and these should be introduced as routine practices in society.

The best way to preserve economic equilibrium and national independence is to inculcate the spirit of swadeshi in production and consumption as far as possible, and establish a sustainable drive for self-sufficiency and self-reliance. National independence need not be mortgaged to the fashionable slogan of international interdependence among the unequals. There will be technology and industry, but they will be based on resources, needs and ecoequilibrium. Consumerism is not a culture to be encouraged for expanding industrialization, nor is competition for international markets desirable. The Swadeshi Science Movement is thus a national movement that values people more than technology or profit economics.

Education and communication have a great role in cementing national solidarity. All Indian languages ought to be developed as effective vehicles of scientific knowledge, and an honest attempt ought to be made to popularize Vishwa Nagari as a common national script for all Indian languages.

There is a feeling that development planning in India has not so far produced the desired results; perhaps, it has aggravated the problems. The Swadeshi Science Movement should set the following planning panorama : the need to plan for a 1000 million population in terms of their requirements in food, clothing, shelter, education, employment, recreation, transport, communication, and other basic welfare facilities.

There is an imperative need to give special attention to the 120 million "underfives" in terms of their protein-calorie and vitamin-mineral requirements for a healthy, intelligent growth. The number of school-going children would be around 300 million, in addition to the current backlog of 444 million illiterates; the whole educational planning and pattern need a thorough overhauling. Next is the labour force of about 400 million, and the type of development strategy to employ them and engage them; it is here that we have to listen to Mahatma Gandhi to a much greater extent, much more intensely than ever before. We cannot ignore the plight of about 200 million retired and aged people; the Swadeshi Science Movement would enlighten people on the need to revive the time-tested cultural and religious festivals and rituals in view of their spiritual, psychological and sociological functions. National renaissance on the material plane must go hand in hand with cultural renaissance.

One usually finds the entire blame for the failure of development planning being placed on population increase, and science and technology are extensively misused to induce, coerce, or force people to accept birth control measures, including abortions. The Swadeshi Science Movement would have to analyse the population problem from the following points of view : (a) the role of nature in increasing, decreasing or controlling population, (b) the moral, biological and psychological effects of the population control measures, (c) the demographic effects of population control, (d) the motives of the foreign financing agencies for population control in the third world, and (e) planning for the entire population rather than resorting to cutting down population. This requires a serious attempt at rural transformation, sustainable agriculture, and right approach to energy, transportation, health, nutrition, hygiene, etc., instead of sidetracking the real issues.

The Swadeshi Science Movement should critically and objectively evaluate the whole series of questions of major irrigation vs minor irrigation, chemical fertilizers vs biofertilizers, polluting pesticides vs pest-resistant crops, cash crops vs food crops, etc. In our tropical agriculture, everything is chemicalized, and natural processes are completely forgotten in our craze for modernization. Modernism is also taking us towards chemicalization of the body, disregarding biological principles, thus causing irreparable and irretrievable damage to our system. The situation calls for utmost vigilance by the Swadeshi Science Movement in all matters connected with drugs and medical practices, food additives and food products, insecticides and pesticides, and even family planning methods.

11. SWADESHI OVERTONES IN SCIENCE AND ECONOMICS

Scientific principles may be universal, but they are modified by regional, cultural and historical factors. Hence, each nation should have a Swadeshi Science Movement.

Similarly, economic principles may be universal, but they are conditioned by regional, cultural and historical factors. That is why Gandhian Economics is a Swadeshi Economics Movement.

Both science and economics will have some common spiritual premises : (a) the concept of man, and the aim of life; (b) the unity of life, environment, biosphere and ecology; and (c) work, recreation, self-discipline, service, worship, self-transcendence, etc. These form the basis of spirituality.

Of the economic premises, classical economics deals with competitions, while socialistic economics deals with collectivism and state ownership. Gandhian economics, on the other hand, is the economics of small farms, natural agriculture, local production, small industries (with or without sophisticated technology), and decentralization. Conceptually, Gandhism is swadeshi in philosophy and practice. The science and technology required for such an economic activity are much different from those in western industrial activities.

The modern industrial economy, whether it be concepts of capitalism or socialism or communism, is subject to increasing criticism. Gandhism is not content in merely criticizing. It tries to establish and to suggest an alternative way of organizing our economic thought and economic practices; and the science and technology required for such practices are of a different nature altogether. The concepts of Gandhian economics are relevant to all the developing countries and have an increasing bearing even on the problems of the developed nations. Gandhian economics deals with the fundamental concepts and strategies of economic development and the problem of a right type of technology for a world living on its accumulated capital. The success of Gandhian economics depends on the credibility of this supporting technology, quite distinct from western technology, which favours centralization, large-scale operations and circualr production, minimising costs and maximising profits. Here is a vast virgin area for the Indian scientists.

12. CONCLUSION

In a country now under the captivating spell of illusory claims of modern science and technology and the concomitant economic theories, it would not be a mean task for the Swadeshi Science Movement to provide a true picture of what really is worth pursuing in science and technology for a sustainable society and how best spirituality can be developed as a science of social harmony. If there is the courage of conviction, if there is faith and confidence in this mission and the nation's destiny, there is then no doubt about success. Truth will ultimately triumph, and this conviction alone should give the needed courage and confidence in the Swadeshi Science Movement.

THE INDIAN SCIENCE MOVEMENT AND ITS OPPONENTS

Suresh Kumar Mahajan*

India seems to be entering an historical phase which may be marked by a sharpening of conflict between science and religion. On the one hand, we are witnessing an unprecedented interest among the young people in the method of science and its use in solving our nation's problems. This is reflected in the emergence and activities of a large number of voluntary scientific organizations — Kerala Sastra Sahitya Parishad, Kishore Bharati, Centre for Science and Environment, Lok Vidnan Sanghatana, Forum of Science, Technology and Society, College Going Scientists' Association and Delhi Science Forum, to name only a few. To the young people working in these organizations, science is no longer merely a means to prestigious and lucrative personal careers. They see in it an instrument of socio-cultural renaissance. These young people, most of them with higher science degrees, have allies and supporters among a large number of professional scientists who, though working within the organized, career-oriented sector, are conscious of the alienation of this sector from the needs and aspirations of a major segment of our society. These voluntary organizations together with the conscientious professional scientists and, in several cases, their forward-looking associations which seek critically to examine the content, organization, performance and policy of our national scientific activity, constitute a powerful science movement whose influence is bound to increase in the coming years.

The more important factors which have contributed to the emergence of this science movement include the progressive broadening of the social base of the scientific manpower and the failure of our S & T activity in the post-independent India to solve some of our most pressing social problems such as poverty and inequality.

In the early years after our independence, a vast majority of our trained scientists, especially those who acquired positions of power and influence on account of their foreign degrees, belonged to elitist, west-oriented sections of our society having little empathy with the masses of

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India and still less appreciation of their problems. To them, science, if it was not merely a means of personal power and prestige, was either an instrument of westernizing India or at best a means of asserting Indian pride by competing with the west on its home ground — an ego trip at individual and collective levels. In any case, they regarded science as essentially a modern western phenomenon to be transplanted to the Indian soil to serve the needs of westernized Indians, the lip service to eradicating Indian poverty, etc. notwithstanding. The only S & T model they could think of was naturally the western model. Priorities were dictated essentially by the relative popularity and glamour enjoyed by the different areas of S & T in the west. They were either not sufficiently aware of the complex relationship between science and the socio-cultural environment in which it operates or, in their anxiety hurriedly to expand the scientific infrastructure to obtain more influence for themselves, preferred to ignore the contradictions between the socio-cultural ethos of the majority of Indians and the requirements of a successful transplant of western S & T. They tried neither to tailor our S & T objectives so as to harmonize them with the material needs and cultural ethos of our people nor to educate our people, not even the students of science, in the elements of the method of science and the scientific temper. However, the expansion of science education has brought into Indian science new recruits with far more heterogeneous social backgrounds and with more intimate contact with the Indian people. At a time when the lacunae in the policy of blindly imitating the western model have begun to become apparent, the more articulate and concerned among the new recruits have begun to make their presence felt in the form of the science movement.

Those in this movement seek to identify the factors responsible for unsatisfactory performance of our S & T and to democratize our scientific organizations, making them accountable to the people and more sensitive to their needs and aspirations. More importantly, they seek to take the method of science to the masses as a means of improving not only their lot but also their outlook, so that the latter can themselves rationally analyse their problems and find solutions thereto. They hold obscurantist and irrational religious and cultural practices responsible for many of the prevailing ills of our society. In their view, science need not be subservient to an immutable cultural ethos. They would rather use it as a means of cultural change and regeneration to create a new set of values which are more responsive to the material and social needs of the majority of people. They stand for a critical re-examination of all ideas and practices, including those which may be considered as elements of our cultural identity. Though they are aware of our rich cultural heritage, they advocate rejecting any such beliefs, ideas and practices, regardless of their origin and antiquity, which do not measure up to critical examination in the context of the present-day needs of our society.

On the other side of the fence, there has been an alarming increase in the activities of various revivalistic and fundamentalist religious organiza-

tions and their supporters in public and in various agencies, including scientific institutions. A spurt of articles in leading newspapers and magazines which directly attack science, increased activities of various god-men who constantly emphasize the magical and the supernatural, open political support to astrology and other religion-based superstitions and orthodoxy, and the emergence of several groups of chauvinistic intellectuals who completely reject the international character of even basic science and who would prefer to isolate India from the mainstream of the world science, are all parts of this anti-science movement.

There is nothing new in this anti-science feeling, which has existed for centuries in India, Indeed, at no stage has the religious establishment reconciled itself to the scientific world view. However, their attacks against science were subdued in the early part of the post-independent India. This was primarily due to the intrinsic strength of the method of science, the contribution made by science in improving the quality of life in the western world in recent centuries, Nehru's advocacy of rationalism and scientific temper and, above all, the absence of a genuine science movement at the mass level. The emergence of the science movement has changed all that in the last few years. Three other factors make the present juncture an opportune time to launch a frontal attack on the entire gamut of science in India. First, the uncritical expansion of an S & T nucleus which was laid during the colonial era to serve the interest of the colonialists and their Indian collaborators has failed to solve the most important problems facing our society, viz. poverty and inequality. This has led to a belated national debate on the organization and content of science in India by scientists as well as the general public. Many among the concerned scientists, technologists, administrators, planners and politicians are groping for new directions. The religious establishment and their intellectual war-horses who still have hope of actually subjugating science and scientists in India see in the present state of uncertainty within the scientific community a golden opportunity to launch their assault on science.

Second, the western S & T model, which we have been trying wisely or unwisely to imitate, is being challenged by persistent anti-science movements in several western countries, thanks mainly to the environmental pollution and the nexus between the mimitary-industrial complex and science.

Third, the rise of religious fundamentalism in the west and the Middle East also encourages their Indian counterparts in their anti-science drive.

Significantly, their attack is not directed at the poor quality of science in India, or its undemocratic and oppressive management or the problems arising out of the uncritical imitation of the western S & T paradigm in India or the failure of science to reduce inequalities in our society or the lack of social responsibility among some establishment scientists — questions which bother even those in the science movement and its supporters. What they attack is the very potential of the method of science and the scientific tem-

per in solving our problems and in providing a value system for organizing our social relations.

Some of them project science as a tradition exclusively of modern west and consider it somehow unpatriotic to permit the use of the scientific method critically to examine our indigenous cultural and spiritual values. They want people to ignore the fact that non-western societies have made major contributions to the development of the world scientific tradition. To them the work of Joseph Needham and D.P. Chattopadhyaya may as well not exist. Some others claim that our ancients knew all that is there to know about the world, implying thereby that there is nothing that science can possibly teach us. Indeed, they go a step further and claim that our ancients had also evolved a higher science (the knowledge of the *within* of nature) which was superior to modern science (derisively called by them as the communicable knowledge of the *without* of nature). They attack the status and prestige enjoyed by science and scientists in today's society. According to one of them, scientists are mere how-men (read Sudras) who must enjoy lower status than that of exalted *why-men* (read *Brahmins*), the spiritual mystics who possess the knowledge of the within of nature, whatever that means.

They are not against war; indeed they get all their learning from and base all their values on Ramayana and Mahabharatha. But they hold modern scientists responsible for all wars. Science to them is intrinsically oppressive and is responsible for all ills in the society. They are not against all technology (some of them actually fly!); they attack technology as materialistic to put unwary technologies on the defensive. But their real grouse is against the pure scientists — the ones who would like critically to examine all ideas and accept conclusions only on the basis of observable facts. Indeed, in the final analysis, all their arguments against science can be tracked to one distinct objective. This objective is that the method of critical enquiry should not be extended to examine the ideas that they use to win followers amongst the believers. These ideas may have to do with various concepts of god and the origins of world and man, the divine sanctions to social divisions into caste, sexes, itc., with unequal rights and duties or the obligations of individuals to the society and the clergy.

Some pretend that there is no real conflict between science and religion. They actually use the rational method and even appeal to observable facts to refute other peoples' ideas. They reconcile their irrational religious claims with the scientific method by asserting that their knowledge falls in a domain beyond the reach of reason and senses. Their method of acquiring this knowledge is never explained and is actually supposed to be non-communicable. Their only demand is that the scientists accept spiritual irrationality as something higher than scientific rationality and the spiritualists as somehow superior to scientists. Those who cannot see the reasonableness of such a deal are obviously insensitive and unpatriotic.

A more curious and pathetic case is that of the intellectual allies of the spiritualists, who have no specific creed to sell but have a general objective of causing confusion by mystifying everything. They openly attack science, because they are irked by prestige and status enjoyed by a handful of establishment scientists in India. These intellectuals do not pretend that there is no contradiction between the scientific and non-scientific traditions. However, they claim equality between all methods of enquiry, scientific or non-scientific. The main complaint against the method of science is that it sets specific, well-defined standards to which all statements claiming to represent reality must conform. This, they say, is an oppressive text which is responsible for all the ills of modern society. They are aware that their cause against science is untenable. Therefore, as a pre-emptive move to escape refutation, they plead immunity from scientific examination. They claim that they have some blessed egalitarian right to attack science from outside science and therefore it is unfair and indeed oppressive to expect them to conform to reason and facts which are the elements of scientific method. One would wish to grant them this democratic right if only they would not themselves use (apparently) logical looking arguments, (supposedly) based on facts, against science. One wonders why they permit themselves to be constrained by such commonsense considerations, when it is useful to them.

In essence, what they want is that they should have access to the method of science while attacking science, but their opponents should not be able to point out the defects in their use of this method. Now, that is quite an exercise in eglitarianism.

The anti-science forces have a wide base of support, including many a professional scientist, thanks to their skill in causing confusion by deftly appealing to the partriotic emotions and indigenous traditions of a people who have in the recent past suffered the humiliation of colonial rule by a western power and are still aggressively trying to assert their own identity as a major civilization at par with and in certain respect even superior to that of their erstwhile rulers. But their demands are completely unacceptable to those in the scientific movement. What they demand is that in the name of some immutable national identity handed down by generations which inhabited this land in the distant past, the people forego the right to improve the material and social condition of the present and the future generations. They are willing to accept science only as long as it subserves the requirements of a culture and social structure based on it and dominated by the religious interests and their ruling partners.

It will be suicidal for science movement to accept this demand, for there can be no science without the right to reject what does not conform to reason or fact. As has been so competently elucidated by Debi Prasad Chattopadhyaya, historically, science in India has suffered by making compromises of a similar nature with the same forces. These compromises led

first to absorption of science by religious obsurantism and later to stifling of all scientific activity, blocked further social and technological progress and ossified an inegalitarian social system — factors which undoubtedly played a major role in our eventual colonial humiliation.

Though the forces of science and reason in India today would appear in the present-day world context to be stronger than in the earlier historical epochs, it would be a mistake to remain complacent. The forces of religion and obscruantism are far stronger. We live in a country where secularism, instead of being opposed to all religions, means kowtowing to all religions. There are winds of religious fundamentalism blowing in our neighbourhood which aid and encourage our indigenous fundamentalism. The identity of our people is so deeply based on religion that they think nothing of killing hundreds and thousands of human beings who owe allegiance to different gods. Ascendancy of religious fundamentalism in this country will not tolerate the scientific temper. Some technology will certainly survive. But the extension of the method of rational investigation into areas which have traditionally fallen in the religious bailiwick will not be permitted.

Those who are concerned about the future of India and who want a democratic and egalitarian ethos to take roots in an environment of material well-being must see through the game and refuse to make suicidal compromises for which pressures are bound to increase. One could see this almost happening at the recent (23-24 January 1983) debate on 'The Scientific Temper and Spiritual Values' held at the Nehru Centre, Bombay. Mere issuing of a statement exhorting our people to inculcate scientific temper had sufficiently provoked certain religious elements to seek a debate with the scientists. These religious elements enjoyed sufficient clout with a premier centre which seeks to promote science among the people to rechristen this debate as a mere group-meeting after the participants had been formally invited for a debate. The scientists who had been asked to debate the spiritual leaders and their supporters were exhorted on the morning of the debate to sit with the same religious leaders and prepare a synthesis between science and religion. It had been puesumed that such a synthesis was actually possible. When some of the scientists opposed the proposal, the influential people found it difficult to understand their unreasonableness. It was not even considered necessary to ask them the reasons for their opposition and the press in the city of Bombay simply decided to black out this opposition, forcing several observers to take vigorous steps to set the record straight. A corrective letter signed by over 40 participants and observers, including the chairman, P.N. Haksar and the convener, Bakul Patel, was published by only one of the five English language dailies in Bombay, all of which had given wide coverage to the rambling lecture delivered by Swami Ranganathananda in the same debate. Later, at least one influential spiritual journalist had the temerity of patronisingly suggesting in a long article that the scientists had no business to participate in such debates, as they were

paid for technical work. And that is the crux of the matter. The intellectual supporters of the religious interests and socio-cultural status quo view scientists as mere technical workers (*Sudras*) paid to carry out the jobs assigned to them by the rulers. Any intrusion by scientists (and the method of science) into the arena of bigger social and cultural issues has to be nipped in the bud and the scientists reminded of their place in the scheme of things before it is too late. To such intellectuals who are far more influential than most scientists and who resent the higher status enjoyed by even a microscopic minority of scientists, the science movement can have no legitimate role to play and must be ridiculed and opposed.

In an environment like this, the nascent science movement deserves vigorous support from all who care for the future of this nation. Not doing so will be certainly more unpatriotic than giving up certain irrational strains in our concept of our national identity.

SCIENCE AS AN INSTRUMENT OF SOCIAL CHANGE: NEED TO INTRODUCE THE CONCEPT THROUGH EDUCATION

H R ADHIKARI*

In the 35 years since independence, India has achieved tremendous scientific and technological progress. A large infrastructure for science and technology has been built and the Indian scientists have been able to accomplish many well-defined tasks in various areas of scientific development. To-day, expertise of a high order in various branches, including many frontier areas, exists in the country. In the domain of consumer goods, we now import very few finished products and the quality of the indigenously made products is reasonably good. although they are not always comparable with those produced in the advanced countries. Thus, during these 35 years, India has been transformed from a technically backward nation to a technologically competent one.

In spite of this phenomenal technological advance, however, the socio-economic development of the country has been, to say the least, far from satisfactory. A large majority of our population still lives under sub-optimal conditions and most of the people even suffer from want of food, shelter and clothing — the basic necessities of life. We may rank high in the industrialized countries of the world or in the stock of manpower trained in science and technology, but the general quality of life in the country is nowhere near that in the technologically advanced nations and is perhaps poorer than that even in some of the not-so-advanced nations. And this in spite of the fact that we have all the technology available right now within the country to give water, food, shelter and basic health care to the millions. The central question that naturally arises from such a situation is: why have the societal benefits of such remarkable scientific and technological progress been limited?

The simplest argument that is advanced to answer this question is that science and scientific development have essentially failed us, because they have not helped us to solve the problems of poverty, hunger and social injustice. What is alarming is that this argument, simple as it may seem, is used for spreading an anti-science tirade in the country by those interested in doing so. There is a growing tendency at present, however, to believe

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in this argument. It, therefore, becomes necessary to point out that this disparity between scientific progress and social development cannot be attributed to the failures of science. One of the reasons of this disparity, and it is a major reason in my opinion, is the attitude with which we look at science and scientific development.

THE EDUCATION SYSTEM AND SCIENTIFIC OUTLOOK

What, then, is our scientific outlook, or our attitude of looking at science? Perhaps it may be interesting to take a look at what the Scientific Policy Resulution, adopted by the Indian Parliament in 1958, suggests. The resolution says, "It (science) has not only radically altered man's material environment, but what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has influenced even the basic values of life and given to civilisation a new vitality and a new dynamism". The resulution says, quite logically, in the end that (one of) the aim(s) of our scientific policy would be "to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge". The resolution thus underlines the importance of science as an agent of changing not only man's material environment but also his thought processes. The fact, however, is that this central role of science and technology in improving the living conditions and extending the mental horizon of our people is not sufficiently appreciated by a large majority of our scientific community. Failure to appreciate this is the result, in my opinion, of an education system which imparts sufficient scientific and technical knowledge, but yet is unable to develop a scientific outlook so essential for understanding the social importance of science.

What, then, is wrong with our educational system? Why is it faulty? In seeking answers to these questions, one has to look at the development of the education system in India. The formal education system, as is in practice today in India was systematically developed primarily under the British rule. To a certain extent, this education system was beneficial for our people. It made us aware of the deficiencies in our knowledge, particularly in the areas of science and technology and thereby also made us understand what we must achieve. However, it must be realized that the principal aim of any good education system has to be development of the faculties of creative thinking and critical analysis. The quality of education offered by the British was, quite obviously, governed by their own colonial interests. The sole aim of the system, therefore, was to produce administrative personnel, who would faithfully carry out orders from the top and uncritically implement policies. The use of education to develop capabilities for self-expression and creative thinking and qualities like scientific temper, or, in general, the spirit of inquiry was deliberately suppressed, as it would constitute a threat to the very existence of the British Raj. In a sense, the

system was need-based education', the needs, of course, being those that suited colonial interest of the rulers.

After the independence in 1947, it was expected that we would evolve an educational system more relevant to our socio-eocnomic needs and the social reality in the country. However, post-independence trends in education indicate that there has been largely a quantitative growth of education with little, if any, conscious efforts to improve upon the qualitative aspects of our educational system. Even a cursory look at our present educational system can show us that it works in an atmosphere of conformity, non-questioning and obedience to authority. Therefore, like the pre-independence system on which it is primarily structured, it hardly leaves any scope to develop the capabilities of innovative and creative thinking and qualities like scientific temper, or the spirit of inquiry. This in spite of the fact that, curriculum-wise, science does occupy a prime position in our overall educational system. The educationists who have formulated this curriculum have apparently realized the important role, so explicitly stated by the late Pandit Jawaharlal Nehru, of science and scientific knowledge in the overall development of the nation. Where, then is the hitch? Why, with so much scientific knowledge, the student is unable to develop a scientific temper?

The hitch lies in our method of teaching science. The entire efforts of our pattern of education are directed towards teaching only the facts in science. This is not to say that facts are not important. But science certainly is not merely a collection of facts. Science is a dynamic process, being developed continuously and scientific truths are always tentative, liable to be changed in the face of new evidence. These essential attributes of science are never imbibed into the minds of the students. The main emphasis is on teaching science as a collection of facts and laws — the laws of physical phenomena, the laws of chemical transformation, the laws that govern biological systems — and so on and so forth. Further, many of our schools do not even have proper facilities to carry out or demonstrate the scientific experiments based on which these scientific facts have been established. These experiments are thus either not shown at all to the student, or are shown in a very slip-shod manner. Consequently, the student's understanding of science is based primarily on what is given ready-made for him in the text-books. He develops an attitude of depending too much upon ready-made information and thus of looking at scientific facts as something that has been proved correct and therefore must be accepted without really going into the how and why of it. This almost amounts to acceptance of the text-book as an authority, so contrary to the very spirit of the scientific method. Where is the scope, in such circumstances, for inquisitiveness and innovation, qualities so essential for developing scientific temper?

Yet another deficiency in the method of teaching science is the lack of appreciation of the universal nature of science and the quality of re-

producibility of scientific data. No conscious efforts are made to impress upon the student that a scientific experiment, performed by anybody or at any place, would give the same results, provided, of course, it is performed under exactly the same conditions, to impress upon him how, actually, a comparatively small number of physical laws seem sufficient to explain a great part of the behaviour of matter right from the huge and massive bodies in space to the minute regions at atoms and atomic nucleus. These essential attributes of science — its dynamic nature and universality — are thus never fully appreciated by the student.

These are some of the deficiencies in the teaching of science. More than these, however, the major and the most significant deficiency in our science education is that it hardly brings out the social importance of science and its close interaction with society. The developmental history of science as a subject, or, as a part of our science curriculum is not given the due importance it deserves. As such, the student is unable to appraise the contribution of scientific progress to social development during various periods of human history. Likewise, the castigation of scientists by religious authorities, and, in general, the opposition to science by religious forces during the process of socio-cultural development of humanity are hardly given any importance. No doubt, modern history texts of high school level do carry some information on the conflict between science and religion, but the topic is metioned only in a trivial manner and without properly bringing out the reasons for this conflict. Even in college level science courses, the distinctive features of religion and science (the dogmatism of religion and its worship of authority as against the dynamism of science and its acceptance of the fundamental right of questioning) are either not spelt out at all, or are poorly spelt out. In most of our academic institutions, even ancillary reading material on these aspects is not suggested to the student.

Futher, even if such literature on this subject is made available, almost all of it describes the conflict between science and religion as exclusively a western phenomenon. A similar conflict in our own country — the development of science in ancient India and its untimely abortion by obscurantist forces — is mentioned neither in the textbooks (of science or history) nor in the more well-known and widely read supplementary source books on history. (One has to turn to the scholarly and perhaps solitary treatise by Prof. D P Chattopadhyay to learn that there actually was such a conflict on our own soil.) Consequently, the student, who is being groomed to be a future scientist, perhaps knows about the castigation of Galilee by the Church, but is unaware of the similar case of Brahmagupta in our own country. The facts that India also had a scientific tradition as ancient as our cultural heritage, that significant scientific progress had been made in this country during the ancient period and had this tradition not been suppressed by vested religious interests at that period, we would have perhaps seen altogether a different picture of modern India, are completely ignored.

On the other hand, the glory of our ancient cultural heritage is pressed on the students time and again. Ancient history is taught, more with the aim of glorifying our past, ignoring the internally conflicting currents of thought in our society. The necessity to critically analyse historical processes as consequences of the changing socio-cultural milieu, to which science and scientific progress have a lot to contribute, is never really understood by the student. The inevitable result is the development of false pride about our ancient cultural heritage.

This over-emphasis on preserving our ancient cultural legacy on one hand, and the total omission of even a mention of the science movement in ancient India, is, according to me, the most serious drawback of our educational system. It leads the student to consider science as purely of western origin and, therefore, to be superimposed on the Indian culture, which is far superior than the scientific subculture of the west.

The net result of such an educational system is that it stifles questioning and thereby inhibits the development of scientific temper in the young student, who later grows up to become a scientist and, under favourable circumstances, may even occupy a key position in one of our scientific institutions. He believes that science is essentially a western phenomenon and therefore, somewhat alien to Indian culture. Secondly, it further leads him to imagine S&T (science and technology) not as methods of enquiry, but as magical cures of our ills. He is thus unable to perceive science as an instrument of social change. The dangerous outcome of this system of science education was realized nearly 30 years after independence when, as late as in 1976, the Parliament found it necessary to incorporate into the constitution, through the 42nd Amendment, the fundamental duty urging every citizen of India "to develop the scientific temper, humanism, the spirit of inquiry and reform".

This belated expression by the parliament further underlines what our educational system has failed to achieve. Thus, a large majority of our scientific community are not motivated to analyse and understand the close interaction between S&T and society. They are unable to appreciate adequately that benefits of S&T can reach the people only if the socio-economic conditions are conducive. If the socio-economic conditions and institutional structures inhibit the spirit of inquiry, the desired results can never be achieved. In the minds of a great many of our scientists, science and the process of scientific and technical change are thus compartmentalised from the overall process of changing the social structure. They tend to identify these two as separate and independent processes.

WHAT SHOULD BE DONE?

The primary need of today is to introduce the concept that these two

processes cannot and should not be mentally segregated; that the actual integration of the two processes can be brought about only if we realize the importance of science and scientific method as a means to alter not only our material environment, but also our thought processes.

Therefore, our formal educational system should be restructured to include the following :

(A) Teaching of the method of science and what it actually constitutes so as to introduce the concepts:

1. that this method provides a viable method of acquiring knowledge and human problems can be solved in terms of knowledge gained thorugh the application of the method of science;
2. that the fullest use of the method of science in every day life and every aspect of human endeavour is essential for ensuring human survival and progress, and
3. that the spirit of inquiry and the acceptance of the right to question and be questioned are fundamental to scientific temper.

(B) Highlighting the development of science in ancient India and the suppression of this science movement by obscurantist forces. Particular emphasis should be given to spelling out the reasons for this suppression. Since material available on these aspects is limited, it would be appropriate if governmental agencies encourage young scholars, working in the areas of natural and social sciences, to take up research projects on these aspects. The Department of Science and Technology may even consider funding such projects.

In order that this entire effort be properly structured, it is necessary to know what concepts should be introduced at what stage of the formal education. Therefore, it is perhaps essential that a survey be conducted to investigate the deficiencies in developing scientific temper at various levels of the society. This should include (school and college level) science teachers, the scientific community, including those who manage our scientific institutions, and most important, students from various age groups right from the primary to the post-graduate level. Properly framed questionnaires should be prepared and information obtained. This will make it possible to ascertain at what stage what part of the above concept should be introduced.

It is obvious that the task is enormous and yet demanding and immediate.

IMPACT OF SOCIETY ON SCIENCE AND TECHNOLOGY

SCIENTIFIC GROWTH AND THE NATURE OF SCIENTIFIC COMMUNITY

Vinod K. Jairath*

The issue of the growth of science has acquired importance in India in recent years. Two polar views have emerged from the discussions: (i) The growth of science is proceeding unsatisfactorily; ways must be found to accelerate the pace in order to achieve prosperity and an egalitarian social structure; the character of modern science is unproblematic in this view. (ii) Modern science is essentially a product of the modern western civilization; it is oppressive and violent and perpetuates national and international inequalities; a humane science existed in traditional India and it should be regenerated in order to foster an egalitarian society.

Such conclusions, in most cases, are not based on any systematic analysis. A study for this purpose should ask the following questions:

(a) What actually exists?
(b) What are the trends in growth?
(c) What is the ideal towards which the growth/movement should be led?

Question (c) cannot be discussed in isolation from (a) and (b). The ideals constitute an 'evaluation' and, therefore, involve values. Thus, there can be several ideals in a society at any particular time, depending upon the interests of different groups. More than one ideal exist, especially in a situation of crisis when contradictions within the system get sharpened. Ultimately, the path a society settles for is decided in the political arena. Of course, the nature of ideals also governs (a) and (b), i.e., depending upon the different interests and ideals, various social groups may arrive at different answers to (a) and (b).

In order to answer (a), viz. 'What actually exists?', we must clearly identify the relevant factors, characteristics, processes, etc., the nature of whose existence is under study. The social phenomenon under discussion in this paper is 'scientific growth'. The factors relevant to an understanding of the mechanism of scientific growth may be extricated from the various

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studies aimed at explaining either the decline or stagnation of science in ancient India and Greece and mediaeval Arabic civilization or the upsurge of 'modern' science in Europe starting with the scientific revolution of the sixteenth and seventeenth centuries. The following four factors may be identified from different studies:

I. SOCIAL STRUCTURE:

In this category, one major aspect has been emphasized: the existence or emergence of a sharp division between manual and mental labour. This division, it has been argued, devalues manual labour and separates it from mental labour, resulting in abstract 'knowledge', which is cut off from observation, experimentation, and practical needs of the society[1,2].

II. VALUES

Scientific growth or lack of it has been explained in terms of values, attitudes or spirit of a society. For example, the so-called scientific norms comprising universalism, 'communism', disinterestedness and organized scepticism, considered necessary for accumulating 'certified' knowledge, are seen as a direct product of the Protestant ethic which emerged in Europe along with the scientific revolution in the sixteenth century[3].

III. TECHNOLOGY/UTILITY

On the one hand, science is seen to be dependent on the technological level attained by a society, as in case of the 'Baconian' sciences, which were accompanied by proliferation of new instruments[4] or the Big Science in practice today, and on the other hand, scientific growth is perceived to have obtained impetus from the utilitarian needs, especially in modern industrial societies, the classical case often quoted being that of mid-nineteenth century German science.

IV. SCIENTIFIC COMMUNITY

One of the important prerequisites for the flourishing of science is the existence of an effectively communicating and well organized community of scientists[5,6]. Such a community requires special institutions which provide a cementing force. The character of these institutions changes according to the needs of the scientific community.

The factors outlined above are closely interlinked and none of them, considered by itself, can adequately explain the growth or stagnation of scientific activity in any society at any particular historical juncture. But in the present paper, I shall focus my attention primarily on the last factor, viz. the nature of the scientific community, in the context of scientific growth.

ROLE OF THE SCIENTIFIC COMMUNITY

The notion of 'scientific community' presupposes the existence of a number of individuals, in a particular society, who are engaged in the pursuit of systematic knowledge about empirical reality. For such a group to operate effectively as a community whose activity leads to growth in scientific knowledge, the following requirements must be met:

(1) an institutional framework,
(2) a paradigm a la Kuhn, and
(3) effective communication.

(1) INSTITUTIONAL FRAMEWORK

Under this head, I include institutions such as universities and research laboratories, academies, societies and associations. A new institution may be created to undertake a certain activity. But the character of an old, already existing institution can be transformed, so that it can start performing a new function. It also implies that an institution created specifically to undertake some activity may stop performing that function effectively in time. Therefore, it is futile to look for any permanent types of institutions conducive to scientific growth. But some, historically determined, centre of excellence or institutional framework is necessary for scientific growth. It draws together the best of the scientists.

One of the earliest prominent scientific institutions of the world was the 'Museum' at Alexandria, opened around 300 BC by Ptolemy, one of the Generals of Alexander the Great. Ptolemy brought to the Museum the then director of "Lyceum" (institution started by Aristotle after his disaffection with the teaching at the "Academy", the institution started by Plato) and many other scholars to establish scientific research. The Museum had its superb library, lecture halls, dissecting rooms, zoo, botanical garden and astronomical observatory[7(a)]. It attracted some of the best scientists, including such giants of ancient Greek science as Euclid, Aristarchus, Archimedes, Appollonius and Hipparchus.

No such definite information appears to be available about ancient India and deserves the attention of the historians. However, the existence of a well-knit community is evident from the "seminar" described in Caraka Samhita[8]

Baghdad was the centre of Arabic science. Around 800 AD, Caliph Haroun Al Raschid started ordering translations of major scientific works of Greece and India. His son Al-Mamun, estalished "Dar-al-Hikma" (House of Wisdom) — an academy of knowledge where Hippocrates, Aristotle, Euclid, Archimedes, Apollonius, Galen and Ptolemy were translated and studied. Similarly, alsmost every major Indian work in medicine, astronomy and mathematics was translated and absorbed. Science flourished in Baghdad,

leading to the setting up of the first Muslim university there in the year 1065; Omar Khayyam was one of its greatest teachers. But it declined soon.

The next institutional innovation was the medieval European universities. It started in the twelfth century with the settling down of increasingly large number of masters and students in certain towns for imparting and receiving education in theology, law and medicine.

> The students formed associations like those of craftsmen to protect their educational and social interests. The craftsmen named their associations 'universities' or 'guilds', and the students appropriated the name 'university' from them. The application of 'university' was gradually narrowed to denote societies of masters and scholars, and there might be serveral 'universities' of medical or law students in the same town. The 'universities' were governed by guild regulations of the usual type[7(b)].

Formal universities were set up at Paris, Bologna, Oxford, Cambridge and Padua during the late twelfth and early thirteenth centuries. Gradually, some Greek and Arabic works of science were introduced in the curriculum, but, essentially, science remained peripheral in the universities for several centuries. The scientific revolution of the sixteenth and seventeenth centuries took place outside the universities. As Ashby[6] remarks, 'The scientific revolution had occurred not through, but in spite of, the English universities. Respectability *vis-a-vis* science was brought to the universities only in the nineteenth century, when the German universities introduced the 'innovative' idea of combining laboratory research along with teaching.

But Ben-David[5(a)] sees the setting up of medieval European universities as of crucial significance for rapid scientific advance.

> One major factor which distinguished Europe from other areas was the development of a relatively autonomous intellectual class. Universities as corporations of scholars, many of whom engaged in secular intellectual pursuits, were a unique feature of medieval urban civilisation in Europe, just as the whole corporate structure of city life was a unique European occurrence.

And he goes on to add:

> It may appear paradoxical to regard the universities as a necessary adjunct to the emergence of modern science, since the new science was in contradiction to what was taught at the universities;........ But the universities were the points of departure for the foundation of new rival colleges in the sixteenth century, such as the College Royal (College de France) in Paris and Gresham College in London and the background for the informal meetings and privately arranged courses from which later the academies of scientists emerged[5(a)].

The single most important institutional innovation in the upsurge of modern sciences was the setting up of Academies of Science in seventeenth

century Europe, starting with the Italian Accademia dei Lincei (1603), English Royal Society (1660) and the French Academy of Sciences (1666). By 1790, there existed 220 of them in the world. The Chinese Academia Sinica was set up in 1928 and the Indian Academy of Science in 1934. Academies were the institutions through which a large number of scattered scientists could share the results of their research. Simultaneously, "journal" emerged as a new form of rapid communication within the scientific community.

But, once again, the fortunes of the academies varied. The earlier dominant status of Royal Society declined in the eighteenth century and the initiative passed on to the French Academy. Even within England, the 'aristocratic' science of Royal Society was challenged by others like the famous Lunar Society of Birmingham, which started taking shape around 1765 and included members like Erasmus Darwin, Joseph Priestley, Benjamin Franklin and James Watt[9].

As has been mentioned earlier, in the nineteenth century, the scientific initiative was wrested by the research-oriented German universities—a model, which has been imitated by universities in each and every country today.

By the middle of the nineteenth century, industrial productivity and competitiveness had been demonstrated to be linked to scientific research and thus followed the industrial research laboratories, their number in the United States increasing from 'about 300 in 1920 to over 1,000 in 1927'[10(a)].

The last of the institutional innovations is the product of Big Science, especially since the Second World War. These are the giant government institutions, especially in the areas of nuclear physics, space research and electronics.

Thus, we see how the institutional forms have evolved in the history of scientific growth and the organization of scientific community. It should also be obvious that simple borrowing of an institutional framework will not automatically make a scientific "community" effective.

(2) PARADIGM

According to Thomas Kuhn, Science in general, or a particular science, grows rapidly after it acquires a paradigm, i.e. the scientific community at large agrees on the fundamental assumptions, the rules of conducting research, and the significant problem areas that need to be researched into[4]. I emphasize the problem areas here as relevant to the context of underdeveloped countries. Even in the west, there have been periods of significant differences. For example, while distinguishing between Baconian sciences such as chemistry and electricity and the classical mathematical sciences

such as astronomy, Kuhn writes:

> Practitioners of both can be found in most European countries, but the centre of the Baconian sciences was clearly Britain, for the Mathematical the Continent, especially France. Newton is the last British Mathematician before the mid-nineteenth century who can compare with continental figures like Bernoullis, Euler, Lagrange, Laplace, and Gauss. In the Baconian sciences, the contrast begins earlier and is less clearcut but continental experimentalists with reputations to rival those of Boyle, Hooke, Hauksbee, Gray, Hales, Black and Priestley are difficult to find before the 1780s.

Without entering into any controversy about the nature of paradigm and the worth of 'normal science' or its dangerous consequences for the spirit of science", all I wish to emphasize is that despite agreement on fundamental assumptions, the nature of basic entities and the rules of the game, it is possible for a scientific community in a particular country to work on problem areas specific to its needs and continue to contribute to the universal body of scientific knowledge. But such a variety of a paradigm. with fairly well-defined problem areas, is essential for a scientific community to contribute effectively to scientific growth.

(3) COMMUNICATION

Free and effective communication among scientists, both within the country and internationally, has always accompanied scientific growth throughout the history. Even during the ancient period, the scientific communities of India and Greece were in touch with each other. We have already seen that the Arab scientists knew the Indian and Greek scientific work through translations. In 770 AD, an Indian astronomer, Manka, was invited to the court at Baghdad. In the Year 830 AD , Al-Khwarizmi, the librarian of al-Mamun, travelled to Afghanistan and India and, on his return, wrote his famous "Al-Gebr We'l Mukabala—from which the word Algebra has originated— supposedly influenced by the work of the great Indian mathematician Brahmagupta. Similarly, Al—Beruni's travels in India and his writings on science in India need no elaboration.

Similarly, effective interaction and communication held together the early European universities and led to their decline with the breakdown in communication.

> The most vivid impression which comes down to us from the medieval universities is their supra-national character. In the fourteenth century there was a cohesion of learning in Europe. Students and teachers could migrate from Bologna to Paris, from Paris to Oxford, and find themselves at home. The cements of this supra-

national movement were, of course, a common language (Latin) and a common religion (Roman Catholic Church). The common language languished and became a dead language. The common religion became fremented into bitterly hostile sects. The cements which held together European universities together dissolved. The free-masonry of learning declined, and with it declined the high prestige and influence of European universities[6(a)].

Japan launched its modernization programme by borrowing from the Western science.

> After 1868, the Japanese government undertook a deliberate program of modernization, a program that paid special attention to the science of the West. The Japanese imported American, German, English and Dutch scientists, engineers and physicians to serve in native universities as teachers of aspiring students. Between 1868 and 1912 over 600 students were sent abroad for special training in the scientific and technological centers of America and Europe. Linguistic barriers were overcome by the translation of Western scientific texbooks and by the compilation of a dictionary of technical words (Japanese, English, French, and German)[12].

For the case of interaction within countries, the example of nineteenth century Germany can be quoted again. 'The German universities founded and sustained by independent states, constituted an intellectual fellowship without parallel in Europe. Their teachers and students were constantly migrating from one university to another and continually interchanging ideas'[6(b)].

Having demonstrated the significance of effective interaction and communication within the scientific community, both nationally and internationally, I will sum up this discussion by mentioning the following modes of effective communication in practice today : (a) journals, (b) textbooks, (c) conferences, seminars, etc., (d) exchanging pre-prints, working papers, etc., and (e) visiting other centres for relatively long durations. Once again, as in the case of institutions, simply borrowing a mode does not automatically aid the process of scientific growth.

SCIENTIFIC COMMUNITY IN AN UNDERDEVELOPED COUNTRY

In the last quarter of the eighteenth century, the European investigators who were engaged in antiquarian studies, so also in diverse investigations of the natural history of India, felt the need for meeting together with a view to exchanging their own findings. This necessitated the founding of a learned society, and it did not take long to establish one such. Thirty

European intellectuals of Calcutta met on 15 January 1784, under the Presidentship of Robert Charles, the second judge of Supreme Court, and resolved to form an association called 'The Asiatick Society' (later known as the Asiatic Society of Bengal and this name was changed in 1936 to 'The Royal Asiatic Society of Bengal') and to hold weekly meetings every thursday at 7 O'clock[13].

This is how scientific community was first established in "modern" India. The institutional framework, the paradigm and the nature of interaction and communication then followed in the same tradition. It fits in very well with the second phase of the three-phase model of "The spread of Western Science" formulated by George Basalla[12]. The three overlapping phases or stages of the model are as follows:

(1) the non-scientific society or nation provides a source for European science
(2) Colonial science
(3) Completes the process of transplantation with a struggle to achieve an independent scientific tradition (or culture)

The model, based heavily on the experience of the United States and Japan, becomes meaningless during its third phase for the underdeveloped countries. It does not take into account the internal dynamics and emergent social structure under colonialism.

In the earlier section, the history of the scientific community has been traced without linking it to the nature of structural changes within the societies discussed. It had to be done because the task of this paper has been defined narrowly. But the nature of the scientific community in underdeveloped countries like India cannot be discussed without a reference to the social structural changes during the colonial and the post-colonial periods.

The Indian society that emerged from the colonial rule may be characterized, with some simplification, as comprising a semi-feudal countryside and the neo-colonial cities with a close interrelation between the two. The semi-feudalism is perpetuated in the countryside by the strength of the urban neo-colonialism, whereas the neo-colonialism feeds itself on the backward semi-feudalism. The neo-colonial culture of the cities is elitist within the country and slavish with respect to the western industrial nations. The semi-feudal culture is authoritarian and in a state of indifference to change.

The scientific community in India is a product of the urban neo-colonial structure and culture. It is elitist within and slavish without. And it does not communicate with the backward semi-feudal structure and culture of the countryside, but feeds on it.

The society was sharply divided along new lines of demarcation with the victory of the Anglicists over the Orientalists in the educational

policy of 1835, when Macaulay stated 'that we ought to employ the funds in teaching what is best worth knowing; that English is better worth knowing than Sanskrit or Arabic; that the native are desirous to be taught English, and are not desirous to be taught Sanskrit or Arabic,...' This is in sharp contrast to the policy of the Arabs who translated the Sanskrit and Greek scientific writings into Arabic, or of the Japanese who translated the English, French and German scientific writings into Japanese. The language barrier thus erected in India made the study of science a reserve of largely the urban elites, who were themselves a product of colonial India.

In creating the institutional infrastructure of science, the Indian scientific community has looked up to the western community of scientists for advice, resulting in mere imitation. The universities, the CSIR, ICMR, ICAR, IITs, etc. are all modelled on western institutions.

The institutional framework can be innovative only if the Indian scientific community has its own independent programmes of research, its own set of problem areas. Here again the neo-colonial mentality operates.

Finally, the present situation looks as follows. The vast majority of the Indian population remains untouched by the achievements of modern science and lives under miserable conditions; the scientific community is simply indifferent to it. The scientific community in India operates in borrowed institutions, with borrowed paradigm through borrowed modes of interaction and communication. In this respect, our "centres of excellence" do a fairly good job in the borrowed paradigm, without making any significant breakthoughs in science. There are certain areas, however, where the interests of the Indian elite clash persistently with the interests of the elite of the western industrial nations. These are areas such as nuclear research, space research, electronics and some industrial sectors. Here we find fairly well defined paradigms, full financial support, institutional innovations and significant results.

Thus, the relation of scientific and technological change to socio-cultural change is a political one. The conditions of scientific growth vary according to the historical experience of a society and the nature of scientific change depends on the internal structure and dynamics of the society. Science is not inherently good or bad, beneficial or dangerous, humane or exploitative and evil. It is the society which makes science a source of prosperity to all or destructive and violent. Therefore, in order to understand the dynamics of scientific change, we must confront the political implications of social structural changes.

REFERENCES

1. *Farrington, B.: Greek Science (Pelican, London), 1963.*

2. *Chattopadhyaya, D. : Science and Society in Ancient India, Research India, Calcutta, 1977.*

3. *Merton, R.K.: "Science and Democratic Social Structure" in Social Theory and Social Structure (Amerind, New Delhi), 1968 (Enlarged Edn.).*

4. *Kuhn, T.S. : The structure of scientific Revolutions, University of Chicago Press, Chicago, 1970 (Second Edition); "Mathematical versus Experimental Traditions in the Development of Physical Science" (1976) in T.S. Kuhn, "The Essential Tension", University of Chicago Press, Chicago, 1977.*

5. *Ben-David, Joseph : "Scientific Growth: A sociological View, "Minerva, Vol II, No.4, 1967; "The Scientific Role: The conditions of its Establishment in Europe", Minerva, Vol.IV. No.1, 1965, (a) 459-60.*

6. *Ashby, Eric: Technology and the Academics: An Essay on Universities and the Scientific Revolution, Macmillan, London, 1958 (a) 45, (b) 20.*

7. *Crowther, J.G.: The Social Relations of Science, Cresset Press, London (Second Edition), 1967; (a) 53; (b) 154-157.*

8. *Satyaprakash: Founders of Sciences in Ancient India (The Research Institute of Ancient Scientific Studies, New Delhi), 1965.*

9. *Schofield, R.E. The Lunar Society of Birmingham.*

10. *Coben, Stanley: Foundation Officials and Fellowships: Innovation in the Patronage of Science, Minerva, Vol.XIV, No.2,1976 (a) 225.*

11. *Popper, K.R.: Normal Science and Its Dangers, in I. Lakatos and A. Musgrave (eds), Criticism and the Growth of Knowledge, Cambridge University Press, Cambridge, 1970.*

12. *Bassala, George: The spread of Western Science, Science (156), 1967.*

13. *Subbarayappa B.V.: "Western Science in India upto the End of the Nineteenth Century," in D.M. Bose, S.N. Sen, B.V. Subbarayappa (eds), A concise History of Science in India, Indian National Science Academy, New Delhi, 1971.*

RELATIONS OF CLASSES AND STRATA TO SCIENCE AND TECHNOLOGY IN DEVELOPING COUNTRIES--THE CASE OF INDIA

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In the last few decades, science and technology in developing countries became a major subject of national and international policies. "Science is now increasingly recognized to be an instrument of social change. Consequently, efforts are being made to understand its socio-economic and political linkages and utilize this understanding in developing science and technology to attain a set of socio-economic and political objectives"[1]. So, the discussions on the means to achieve the objectives are directed at understanding the interrelationships among technological and social features. In many cases, these interrelationships are treated as national entities, which in reality do not exist due to the ambivalence of the political and bureaucratic elite in the implementation of science and technology policies.

It has been noted more and more that all the social classes and strata in the developing countries cannot use science and technology in the same way. The results of scientific researches have not vitally affected the living conditions of the poor people. For example, it seems generally accepted that the fruits of the Green Revolution in India ripened for the rich farmers, while the condition of the poor farmers and landless labour deteriorated further[2]. Such maladaptive processes in the implementation of scientific and technical change could be explained by a complementary aspect of development, the behaviour of classes and strata towards the use of science and technology. We define this phenomenon as relations of classes and strata to science and technology. In respect of people in a class of stratum, these relations are measured by their (a) objective interest in science and technology

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as the basis for development; (b) capacities to generate scientific and technological results; (c) abilities to apply R&D results; and (d) motivation in the development of science and technology. It is necessary to investigate these relations to understand the contradictions in development and the relatively slow pace of progress in achieving the goals of S&T to solve socio-economic problems of the people, in particular of the weaker sections of society[3]. This needs complex sociological analysis, including the collection of a broad spectrum of data. We can only make some observations and describe the situation based on the studies published in India to raise a few questions for further research.

In this paper, we try to outline the S&T relations of the main social classes and strata in the contemporary Indian development scene. India is an instructive example to show the deviations between the assumed goals of S&T and what has actually happened. Over the years, India has built up an impressive base of science and technology. She has about 2.5 million scientific and technological personnel and in this respect ranks third among the countries of the world. The national expenditure on research and development and related scientific and technological activities was of the order of Rs. 8100 million in 1981-82. She occupies the eighth position among world's top producers of research publications. Science and technology has been brought into the purview of national planning to synergise the development process with the purpose of ensuring self-reliant national economy and social progress. However, there are serious problems in implementing scientific results which are of interest to all classes and strata[4]. In this context, it is felt necessary "to examine the socio-economic and political constraints to the use of science and technology for development"[5].

S&T RELATIONS OF CLASSES

Different classes of people have different relations to science and technology. These classes are formed by rich farmers, industrialists, traders and by those who have interest in maintaining these classes. It seems necessary to distinguish first of all between those involved in the production process earning out of profit in production and those who earn money essentially out of the circulation process[6].

THE RICH IN INDUSTRIAL AND RURAL SECTORS

These are the classes of people who have entrepreneurial capacities; they also constitute educated people who are interested in smashing the fetters which come in the way of speedier growth[6]. They recognise science and technology to be a decisive basis of growth. They mainly determine the science policy of the country as expressed in the Scientific Policy Resolution of 1958[7]. The groups formed by the coalition of this middle class and the

political elite are running the country. These groups are interested in the development of science and technology on long-term basis. But there are two restrictions: (a) They concentrate on natural and technological sciences and some pragmatic instruments for management. They are not interested in a really scientific outlook and scientific temper, including social sciences and philosophy. (b) They are not interested and able to change the relations of production lest the application of S&T be retarded in several strata. But this group will promote S&T in several branches of economy to have a skilled labour class and agricultural technology necessary for both higher rates of growth and increasing the purchasing power of the masses for profit.

The majority of the R&D activities are supported by the central government. In 1980-81, the central government spent 77%, the state governments 9% and the private sector 14% of the total S&T expenditure[8]. According to the data available for 1977-78, there were 312 research institutes supported by the central government, 166 institutes supported by the state governments and 348 in the private sector. There are 120 universities, more than 800 medical colleges and 106 agricultural and veterinary colleges[9]. This class of people have decisive influence on policies at central and state levels. The rich industrialists and agriculturists direct the development of the scientific capabilities of India. This group possesses the main capacities to apply R&D results. By deciding the governmental policies indirectly, they influence the public sector industry. This sector is one of the major users of S&T and its output to a great extent depends on the technological level of its performance. Actually, there seems to be a hard competition between public and private sectors in terms of quality, performance and implementation of scientific results, combined with the battle of groups either favouring the policy of technological self-reliance through assigning priority to the application of indigenous R&D results or the import of technology from developed countries and the multinational companies[5]. We find much criticism of the public sector relating to its low contribution to the gross domestic product, to the great differences in the level of technology and performance[10]. To understand these trends, the role of management and bureaucracy needs to be reflected upon. The private sector in Indis's industry participated in the programme of rapid industrialization launched in the mid-1950's and achieved remarkable growth in quantitative and qualitative terms, as exemplified by the traditional business houses using S&T.

The central problem in India may be considered the flow of S&T inputs to agriculture, essentially determined by the group of agriculturists comprising owners of huge farms and the rich peasants exploiting agricultural labour. Uptil now about 15% of rural households possess 66% of the land and also benefit from all credit sources to the tune of 66% . This bias in property of the main agricultural means of production and land must be the decisive cause of favouring the rich in using S&T. "Technology means invest-

ment. Even without mechanisation, fertilizers, insecticides, etc. are indispensable in rearing the present high-yielding varieties. Apart from the defects in distribution prevailing in this case, as in other items, managing the wherewithal to purchase such things is a problem by itself. Naturally, much as they try, the poorer sections fail to secure all that is necessary"[7]. No doubt, the modern Indian farmer is an enlightened person. He understands the significance of the use of fertilizers, plant protection, chemicals and agricultural machinery. He is a manager whose main work is to procure inputs in time and to organize family as well as hired labour, so that they work productively[11]. But such behaviour is intimately connected with property and is not an outcome of enlightenment alone. Many case studies in the last decades show the degree of application of S&T results and of innovations in agriculture which are closely related to the levels of income and land holdings[11]. An investigation in rural Kashmir shows the following figures for the adoption of five essential innovations (modern implements, fertilizers, agrochemicals, high-yielding seeds and livestock)[12].

Average Adoption Score at Dirrerent Levels of Income

Income Group Rs/Month	Average Adoption Score	
	Village A	Village B
Up to 150	1.60	-
151 - 300	1.42	1.27
301 - 450	3.88	2.53
451 - 600	4.00	2.69
601 - 750	4.41	3.40
751 - 900	3.50	-
901 - 1000	6.00	-

The coefficient of correlation between income and adoption for the two villages is 0.39 and 0.59. The differences in the two villages show the influence of other variables like education, family type, occupation, religiosity, etc., which themselves are influenced by income and extent of land-holdings.

There are sharp differences in the levels of development of various Indian states, which are also related to the possibilities of using S&T by several strata of society. They show close correlations between the extent of land-holdings, progress in the consolidation of holdings, irrigation, sinking of tube-wells, consumption of plant nutrients, etc. For instance, land-holdings vary from 11.58 hectares per agricultural household in Uttar Pradesh to 0.69 hectare in Kerala and availability of plant nutrients from 72.4 kg. per

hectare in Punjab to 1.8 kg. in Assam[11]. The combined effects in the imbalance of opportunities to implement modern rural technologies are such that in 1973-74 only about 17% of the total cultivated area was covered by the Green Revolution, the main form of bringing science from laboratory to land[13]. As mentioned earlier, the stratum comprising rich farmers was in the most advantageous position to have the benefits of the Green Revolution.But this has happened in a contradictory situation. On the one hand, the rich farmers recognize the advantages of using science-based implements, seeds, fertilizers, etc. On the other hand, the biggest retarding force is cheapness of labour; wide-scale unemployment and complete dependence on only one trade, viz. agriculture, has reduced wages below subsistence margin. With labour available all around at such wages (one kg. of rice plus Rs. 1.00 - 3.50 in cash per day), there is little inducement to turn over the machines[7].

The promise of eliminating poverty by attacking at its roots, particularly by radical redistribution of agricultural land, remained largely unfulfilled. The failure of land reforms perpetuated the dominance of a few elite who in collaboration with the bureaucracy greatly restricted the percolation of the benefits of development to the masses.

Those who benefited from the industrial and rural development programmes show to a large extent rational behaviour, propagate 'scientific temper' and secularism. They appreciate science and technology and make many efforts to develop and to use them for the progress of the country, but within the framework of the existing social order.

TRADERS AND MONEYLENDERS

There is also a group of people who make their money essentially out of the circulation process, i.e. trade, moneylending, hoarding, rents for land and property, etc. Because under conditions of land scarcity, profit on circulation tends to be high, these groups are uninterested in and sometimes in direct opposition to any measure to raise growth and incomes[6]. These groups of people need science and technology only to ensure and to raise their income. They seem to have neither built up special sub-groups of intelligence and of R&D capabilities nor have a special policy for R&D.

Though these groups do not use S&T for their own activities to a considerable extent, they influence essentially the possibility of increasing the opportunities for the farmers and entrepreneurs of small and large scale industry to reach higher levels of technology. The ambivalent nature of the ruling coalition is also expressed in the fact that at the centre the policy is directed to have broader implementation of S&T in several areas of production and for the weaker sections of society, but closer to the villages to meet the vested interests of rich landowners, traders and moneylenders. There is much more conservatism and channelling of the results of S&T to the rich farmers and entrepreneurs[6]. The weaker sections do not at all benefit from trade and moneylending.

Loans from the financial institutions are not available to those who do not have the property or assets to show as guarantee in case they are unable to pay back the loans. Some efforts initiated by the government to provide money, technical know-how and marketing assistance to the oppressed people did give encouraging results, but these could not be carried to a self-sustaining stage. Generally, there are situations of conflicts between the politicians and the bureaucrats in the implementation of such programmes. The former use social criteria and the latter apply sound economic principles in their decision-making. Unless a compromise is arrived at between them, the programmes for the weaker sections cannot succeed.

The class of traders and moneylenders is either indifferent to S&T or is inimical to it. It forms a force by posing religion against scientific temper. It also spreads elitist ideologies having powerful traditions in caste system and lamenting that the poor people are unable to acquire and use science and technology.

S&T RELATIONS OF MIDDLE CLASSES

In India, the middle classes are the owners of the means of production. They are not exploiting hired labour, but in many cases are working partially as hired labour. These classes form a huge segment of population, the major portion of which is in rural areas comprising middle and poor farmers and artisans. They have a paradoxical relation to science and technology based on two facts: (i) they have a middle position in between the rich and the working classes; (ii) in terms of the ongoing development process they are in a transitionary state.

The middle class has an objective interest in S&T to ensure higher income and to achieve economy of labour. But the members belonging to it have very limited opportunities to use modern technology. Thus, their interest in S&T is combined with the historical perspective they will choose. There are four perspectives: to become a rich farmer, to join cooperative forms of production, to ramain in the present state or to descend to working class or to become paupers. The use of science and technology by the middle and poor farmers on wide scale and by other rural workers to improve their economic conditions requires socio-political change and rigorous implementation of the government programmes. In the past, the programmes of rural development, particularly for augmenting the technical ability of the poor farmers and creating conditions for technical change in rural areas, could not be implemented in their true spirit. The benefits of these programmes went either to those who were rich or to those who were politically influential.

The middle position of the farmers may explain the fact mentioned by Gramsci that the peasants though having an essential function in reproduction process do not bring forth a stratum of intellectuals, i.e. organic'

intellectuals of their own[14]. Under capitalistic conditions, they can use only results of R&D systems determined by rich industrialists. This may be the cause of the prevailing 'information-push-models' adopted recently in India's science and technology policies.

It is a main feature of these strata to have very little capacities to use modern rural technologies. They are living either at a subsistence level or below the subsistence level of economy. Consequently, they are unable to accumulate and invest for modernization of production. The vast majority of poor farmers cultivating their lands as individual farmers with very little land-holdings cannot effectively apply modern implements in farm production. Instead, they are forced to work hard. Their children from a great fraction of school dropouts. During 1972-77, 82.5% of children of the farmers in the 6-11 age group were enrolled, but 63.1% of them dropped out at the primary stage for socio-economic reasons[6]. The consumer expenditure as percentage of net receipts for the poor peasant-households with annual net receipt less than Rs. 600 runs from 113% in Punjab to 309% in Karanataka. This gap in the case of the majority of people is bridged by a growing indebtedness to moneylenders, rich farmers, etc. So, the poor peasants find that they can neither invest, nor bring about, nor adopt new technology in agriculture[6]. Contrary to the great efforts of government and progressive organizations to bring science from laboratory to land for hundred of millions of peasants, we find relatively slow progress.

In all the rural development programmes, the rural workers, especially the artisans, were not given their due place. They were neglected as irrelevant, unsophisticated and unproductive workers in the name of modernisation. The possibility of increasing their economic conditions through the improvement of traditional technologies has been missed. The result was that rural artisans by and large have not been able to avail of the opportunities created by rural development programmes. As a result, most of the artisans are rendered unemployed and are gradually losing their identity in the village society[15].

Due to the paradoxical position of the middle class, we observe different lines of behaviour towards S&T. Many try to use results of S&T and to educate themselves and their children. Others remain uninterested and resign to their fates. Most of them uptil now do not recognize that use of S&T by them needs land reform and cooperative operation. The failure of cooperatives in most of the rural India shows a very positive influence on motivation to use scientific results and for education[6]. The extensive discussion on "appropriate technologies" is directed to the promotion of the interests of the government and creating opportunities for the middle class.

In terms of historical perspective, the working class and its core, the industrial workers, will play the most progressive role in development and application of science and technology. This class consequently is interested to use science and technology for the benefit of the masses to which the members of the working class themselves belong. They are also interested in scientific method of production and in the improvement of the existing socio-economic conditions. But the working class is alienated from science and technology. Its members are used as means of exploitation, which is evident from the deteriorating industrial relations between them and the owners of production. They are not ensured "intelligent participation in social and economic development"[16]. In some cases, the working class has been able to recognize its destined role. For instance, the staff association of the Oil and Natural Gas Commission vehmently opposed the government proposal to form a company for engaging foreign consultants and companies for off-shore oil exploration. It insisted upon the government to make use of the national capabilities to keep up the morale of the working class.

Potentially, working class influences decisively not only the application of science-based technology in production processes but it can also creatively improve technology itself. In socialist countries and in a few other countries which have accepted socialistic pattern of society as well as developed capitalistic enterprises, workers make proposals for improving technology and its use and the organization of production. Uptil now this activity seems to play little role in India. It should be borne in mind that working class has little influence on science policies, though some intellectuals relate the interests and ideas of working class to the progressive aspects of India's science policy. They stress the necessity of social changes to enable the working class to play an active role in science and technology and applying them for promoting the interests of the masses.

The knowledge, skills and actions of working men bring science and technology to real life and inject efficiency in society. But their present alienation prevents advantage being taken from these opportunities. There is relatively little information and reflection on the role of working class of India in science and technology. In this sense, there is hardly any difference between public and private sectors. It is also quite clear that the rural workers lag for behind industrial workers in the fields of education, organizational abilities and technical skills.

The left movement brought to the fore leaders and intellectuals who reflect scientifically on the role and obligations of working class in alliance with other progressive classes and strata to develop and direct science and technology. But this did not happen in India. On the one hand, due to the prevailing social conditions, the working class, being influenced by traditional ideologies and behaviour, could not develop into a major force. On

the other hand, the adaptation of workers' aristocracy to the given conditions led to a passive and dependent position of workers *vis-a-vis* science and technology. A detailed study of the social relations of science and technology of this nature should bring out why millions of unemployed and poor people in developing countries are fully cut off from the mainstream of science and technology and how social change must alter their perspective.

INTELLIGENTSIA AND MANAGERS

The class of intelligentsia and managers includes high ranking officials, scientists, technologists in governmental institutions and public and private sectors of industry. They do not constitute a monolithic stratum. There is not only a division of labour among them, but they have distinctively different relations to science and technology. In fact, intelligentsia should be considered as a social stratum consisting of groups belonging to several classes of society. We have the rich and the not-so-rich classes like educated owners of private enterprises or the medical practitioners or lawyers running private practice. There is the mass of intelligentsia working as clerks, administrators, scientists, engineers, teachers, managers, etc. Basically, the interest of all members of intelligentsia is in the development of science and technology as a source of either profit to getting higher salary because of their being engaged in special occupations. As a result, their thinking is conditioned by the dominating classes and strata and on lines which are not in the interest of the social imperatives and goals of the society.

In the realization of the social role of science in society, the intelligentsia is divided into fractions related to several strata and classes as described above. Indian intelligentsia played a leading role in the independence movement. The historical accounts of the careers of leading scientists in pre-independence era make it clear that their dedication to scientific research was fired by the national freedom movement. In the face of mass proverty, science and technology was visualised by them as one of the powerful enterprises to alleviate the miseries of the Indian people. They had shown intense commitment to the development of a self-reliant base of science, technology and industry. In their own ways they envisaged how the benefits of science and technology could reach to the majority of people[17]. As a result, they had made outstanding contributions to science, leading to worldwide acclaim. In the present time, science and technology policies are also influenced by the scientists and technologists. But a large proportion of them and the other strata of the intelligentsia such as the administrators and above all the officials do not have commitment of the kind which was present during the freedom movement. They have little to say about economic progress. "The white-collar elements are being

increasingly pushed to the margin. Politically and socially conscious, they are acutely resentful of their decline and feel sharply alienated from the social order which they hold responsible for it"[17]. Also, most of the intellectuals feel themselves superior to manual workers. So far, there has been no attempts for seeking an alliance between the intellgentsia and the working class which could bring about new and more creative role of intelligentsia to use science and technology in the interest of the masses. It is the function of intelligentsia to produce scientific and technological results and diffuse them in the society. Of course, with the efforts for industrialization and modernization of services along with the scientific potential developed in the country, the intelligentsia had enlarged and there is growing consciousness and uneasiness for their social roles in meeting the national goals of self-reliance in the field of science and technology. However, in reality, bulk of the intelligentsia depends on the application of scientific results by the rich classes and other strata. This may be the main source for sharp differences in the motivation of intelligentsia.

However, we find various strata of the intellgentsia content with the present state of affairs, because of ralatively good conditions for work and living available to them. The strata having a high sense of social responsibility do feel and express the necessity of further social change to use science and technology for progress and for the benefit of the weaker classes and strata of society. Some sections in these strata see that scientific and technological activities in research institutions provide them opportunities for jobs, but they are more or less disappointed with their present status. These sections consider a bureaucrat as "wearing a cold stolid face so far as common people are concerned"[7]. Many scientists voice their grievances and say that such "an organisation cannot gauge people's needs and react to them"[7].

The social progress in India will depend largely on the changes in the relations of the several classes and strata to science and technology. These changes in turn depend on the changes in the socio-economic conditions as well as the enlightenment and the consciousness of the classes and strata. The centre-piece of social progress is that various classes and strata have a decisive influence on the development and use of science and technology. In India, the possibilities of the existing order to provide strong social relations of the masses with science and technology do not appear to be exhaused.

REFERENCES

1. *Rahman, A., End of Colonialism and the Development of Science Policies for New Nations. in: Science and Society, Ed. by A. Rahman and P.N. Chowdhury, New Delhi 1980, p.27.*

2. *Cf. Agrarian Relations in India, Ed. by Arvind N. Das and V. Nilakant, Manohar 1979, p.48 ff., 97 ff.; An Approach to the Science and Technology Plan, January 1973 (National Committee on Science and Technology), p. 25; National Seminar on Science, Technology & Development in India, initiated by All India Peace and Solidarity Organization, 6-8 February 1981, Bangalore. p. xxiii, 8 ff., 12 ff., 85; Science, Technology and Development, Essays in Honour of Prof. A. Rahman, Ed. by K.D. Sharma and M.A. Qureshi, New Delhi 1978, p.220, 245 ff. Sau., R., India's development Strategy: Crisis and conflict, in: International foundation for development alternatives, Dossier 12, October 1979, p.45 ff.*

3. *Cf. An Approach to the Science and Technology Plan, January 1973 (National Committee on Science and Technology), p. 24, 45; Report of the Working Group on Science and Technology for the Sixth Plan (1980-1985) - Planning Commission, New Delhi, December 1980, p. 31 ff.*

4. *United Nations Conference on Science and Technology for Development 1979, National Paper of India, p. 16, 26 f., 30 f.*

5. *National Seminar on Science, Technology & Development in India, 6-8 February 1981, Bangalore. Background, p. 2.*

6. *Agrarian Relations in India, Ed. by Arvind N. Das and V. Nilakant, Manohar 1979, p. 100/101.*

7. *Cf. Science and Society, Ed. by A. Rahman and P.N. Chowdhury, New Delhi 1980, p. 418-420.*

8. *Research and Development Statistics 1980-81, Government of India, Department of Science and Technology, New Delhi.*

9. *Qureshi, M.A. The Growth of Science and Technology, Indian and Foreign Review, Vol. 19, No. 23, 15-30 September 1982, 10.*

10. *Remove curbs on production, PM tells Ministries. The Hindustan Times 9 February 1982, p.1; Time to tone up public sector units: Sethan, The Hindustan Times 13 February 1982, p.7; Lahiri, B., Growth and Performance of Public Sector in India, in: Yojana, 1 July 1980, p.14 ff; Sau, R., India's development strategy: Crisis and conflicts, in international foundation for development alternatives, Dossier 12, October 1979, p.47.*

11. *Randhawa, M.S., Green Revolution in India-Progress, Problems and prospects. Indian National Science Academy 1979, p.11.*

12. *Aslam, M., Social Implications of Technological Changes in Rural Kashmir, Delhi 1981, p.16 ff., 75 ff.*

13. *Sau, R., India's development strategy: Crisis and conflict, in: international foundation for development alternatives, Dossier 12, October 1979, p.45.*

14. *High rate of school dropouts worries govt., The Times of India, 9 January 1982, p. 7.*

15. *Rahman, A. et al: Influence of Metropolitan Proximity on Skill Formation of Rural Workers - A Case Study of Haryana, NISTADS, New Delhi, 1982.*

16. *Rai, A.N., Workers Educaion: An appraisal, in: Yojana, 1-15 May 1981, p.35-36.*

17. *Karlekar, H., Why the Indian white collar is angry, in: Indian Express, 21 February 1982, Express Magazine, p.1.*

AN ESSAY ON THE POLITICAL ECONOMY OF DEVELOPMENT

VITHAL RAJAN*

1. "The aim of many ruling elite is not to relieve poverty, rather the contrary, to make sure that the incomes of the masses are kept low and social services restricted." — Gunnar Myrdal & Dudley Seers — Express Magazine — 1 August 1982.

What Myrdal has said is not new, and has been said with greater and wider force by others. What is poignant is that a "sarkari babu" should say it, after decades of concentrated effort to prove the contrary.

2(a) Of all the objectives adopted by the Indian elite to relieve the miseries of the poor, only that of the Grow More Food Campaign, launched in the '40's has been partially achieved after 35 years of effort. Our Blocks remain undeveloped, Panchayati Raj is only landlord rule, and the Green Revolution has left most of India a dusty brown. Yes, we do grow more food, but this does not mean that more food is available to the great majority who need it.

2(b) The bulk of the population remains below the poverty line. The TRICKLE EFFECT, on which so much faith was pinned, has trickled away as was expected into selected pockets of growth. In fact, one can define Mal-development as Selective Development.

2(c) The real, concrete aim of our development strategy is Political Stability. This has been achieved in different ways — by consolidating the power of the rich farmers under the Green Revolution, particularly in strategic areas such as the Punjab; by winning over a section of middle and small farmers with cattle under Operation Flood, again around arterial roads leading to key urban centres, and so on. It is now hoped to win another section over by splurging money into Social Forestry, which should really be re-named Big-Biz Forestry. Our development strategy, then, remains what it was under the British, and is a follow-on from them, when the Defence of the Realm had primacy over other issues.

3(a) The nation is not the victim of a conspiracy, but rather of a process of social degenerative development. Most of us really only understand the Culture of Power. Whether a scientist, a sportsman, a musician, or a car-

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penter, we would rather only be a joint-secretary to government, and each profession or association of people is moulded on the steel-frame of Indian bureaucracy.

3(b) The Indian middle-class, from the clerk to the high bureaucrat, executive, or scientist, runs the system on behalf of the elite, and mediates between the pyramid of political power, and the pyramid of money power. The middle-class resides and acts within its own pyramid of prestige power, and the individual gains satisfaction sliding up the narrow confines of this structure. This pyramid existence is the legacy not only of British imperial rule, but of Hindu Brahminism.

3(c) What this means is that the men who pull the levers, view the world, people, and their problems only through the prism of their own elite interests. Hey Presto! the world is reshaped closer to their hearts' desire, in a way that would have baffled Omer Khayyam. In our political culture, this is what I call the Big Tradition of the Learned.

3(d) The Little Tradition of the Unlearned just ignored all this, and confined itself to running life in the village. It did not matter whether Rama ruled or Ravanna ruled. The Little Tradition, of course, absorbed quite a few of the persuasive Big Tradition values. For example, today casteism is shared up by both. The Big Tradition, sensing that its vision is turned in on itself, has adopted an eclectical approach to the solution of worldly problems. This has been translated, famously by more linear western scholars, as tolerance — of religions, political thecries, and of technological options — Everything is allowed, as long as nothing matters.

3(e) A fascinating expression of this traditional eclectism is the way the ruling elite is pro-everybody. The middle class is solidly pro-western; its bureaucracy is naturally pro-Russian; and its very top elite is shrewdly pro-Chinese. This is every man's Hanuman car. Capitalism is the chassis. Authoritarianism is the engine. And appropriate technologies are the gadgets.

4. The elite's mode of political control is different for urban areas, and for rural areas. Despite the slogans, the elite is very happy with the urban working class centre of organized labour. This proletarian centre has been co-opted into the system and is safely enmeshed by visible legal and economic bonds, as well as by invisible political and caste bargains and trade-offs. It is the urban periphery of unorganized labour, of lumpen proletariat and bourgeoisie, and the destitute that causes concern. Methods of control, pacificatiar, and acculturization span from the escapism of the Indian cinema to populist, regional and ghetto politics. A communal or fascist outrage can always be perpetrated to consolidate power.

The rural areas, in terms of political control, present almost the reverse picture. The non-peasant periphery is very well controlled through customary and caste practices, through money-lending which keeps most on the perpetual edge of survival, and by rushing charity at the last minute after drought or calamity. The periphery in rural areas is prostrate. However, the rural centre composed of the peasantry, the agricultural labour, the small and middle farmers, is large in size and sees this with discontent, offering considerable challenge to stability. Development strategies have tried to pacify this group, section by section, region by region. It is necessary that strategies should follow rapidly one upon the other, so that even before the failure of one has sunk in, the hope of another can be held up. Genuine development, charity and gimmickry are rotated faster than crops. If all else fails, recourse can be had to the goondaism of the landlord's unofficial policemen, or to the official goondas of the police force.

5. The United Nations could term this the Fascist Decade. If fascism is a failure of civilization, the world is full of failure. We have the 1st World of Failed Imperialisms, the 2nd World of Failed Revolutions and the 3rd World of Failed Capitalisms. The 1st, 2nd and 3rd worlds under the hammer of slump flation, recession, economic crises, whatever are all veering far to the right on their authoritarian axis towards a dangerous mixture of economic failure, fascism, belligerency and perhaps war. In other words, we have every right to expect both Blucher and Night to come.

Let us ask the famous question: What's to be done? Or, more modestly, what's to be avoided? The option may not be a grand choice between the Green Revolution and the Red Revolution. It may be only a simple question of some development rather than chaos. If we are willing to accept the simpler choice, the very first necessity is a general realization in elite circles that eclectism elevated to the level of transcendental meditation will not serve. We should not continue to fool the people (as practised by the Right), or to confuse the people (as practised by the Left).

6(a) If one espouses pundity, one must come out sooner or later with a sutra. Mine is : Learn from Taiwan or Seoul. We are no more capable of learning from Dachai, than I am of learning from Einstein — Americans, while busy telling Third Worlders to look at the model markets of Singapore and Hong Kong, were at the same time pushing through land reforms in South Korea and Taiwan. They not only got pacified forward bases but also client showpieces.

We have been torn apart between piety and greed. We have carried out land reforms on paper, while leaving landlordism intact on the fields. But now, if the ruling elite is to survive, it must cut off its landlord supports in rural areas. This is going to be very difficult, and hit us where it hurts most. It is the landlord structure that is the engine of elite wealth accumu-

lation, for it fuels the blade economy, props up the political parties, keeps labour in check, etc., while maintaining stability over the bulk of India. To call for its removal is like calling for the Deluge.

6(b) No, I am thinking of a modified Zaibatsu plan during the transition period to help the bigger landlords switch to an industrial base of power. The mechanisms I leave to government which is expert in giving tax-holidays, industrial grants, export credits, loans, infrastructure assistance, etc. But the smaller landlords and other parasites and hangers on will just have to be abandoned.

6(c) The ruling elite must be prepared for a jump from rigid structural control of rural areas to a floating negotiable dependence on independent structures of small farmers and peasantry.

7(a) This means, ersatz self-reliance and self-sufficiency. For, the real, organically grown staff will only lead to red bases, police action in disturbed areas, Amnesty International reports, etc., which I am sure we all want to avoid.

7(b) For ersatz self-reliance and self-sufficiency, we need to make some clear technology and development strategy choices.

My first choice is to be against the choice of Buying to Survive. Let me illustrate the point. If we need a diversion, should we buy Juguars or hold the Asiad? I prefer the Asiad. For health, should we go in for hospitals or preventive medicine programmes? To support the arts, shall we construct theatres, or help street play groups? I lean towards barefoot doctors, and street plays.

Similarly, I prefer development of the community, and for the community, and not for the market.

The black Russian fear of being unable to provision the urban areas need not haunt us. The small Indian farmer, given a chance, is highly productive, and production will outstrip rural consumption. We can use well-known price mechanisms, and the principle of inducing urban tastes to get back funds and produce into the economy, without benefit of commissars (It is difficult in a hot country to be brutal in an organized way).

7(c) My second choice is for the diffusion of productive practices that can be utilized and developed to benefit by the small farmer or artisan, rather than the implantation of expensive inputs, a la Green Revolution.

For example, ICRISAT down the road, has discovered that certain pest attacks and bud necrosis in groundnut can be controlled by adopting early sowing and close planting practices. Such practices could increase the yield of the farmer, but not his dependence on elite structures.

On the other hand, ICRISAT says that pest control in pigeon pea can be achieved by using hybrid cultivers. I suspect this could be expensive, or at least dependency-making, unless one took it down closer to the farmer, and diffused knowledge on how to cross pigeon pea with wild pest resistant strains.

Again, soil and water conservation can be improved by using wider furrows, and contour ploughing techniques. For energy conservation, the use of the smokeless chula,the bullock-drawn tropicutor, the windmill and the biogas unit can all be patiently worked out area by area. Indian Zebu cattle can be improved by careful breeding. For all this, what is needed is not technological showmanship, but a concrete understanding of the farmer's world. We will find he is very enterprising and creative, while the research institute, bank and government department are rule bound, ignorant of local realities and impractical.

7(d) The bitter pill in pushing such practices is that they will not win massive vote banks for anyone; no bureaucrat can build up a UN reputation on them; and, of course, they will give nobody any profits. Is it not a shame that we have known the Smokeless Chula for over 30 years, but nobody wanted to be known as the King of the Kitchen, so it is left to an expensive German team, teeming with Ph.D. theses no doubt, to set up an experiment in Himachal Pradesh?

7(e) I am pleading for the diffusion of effective and useful practices to help communities come close to self-reliance and self-sufficiency.

But take the fashionable case of Social Forestry. Here, intensive research in needed to understand the complex of legal, economic, sociological factors involved in getting villagers and tribals to grow trees by themselves, and for their own use — as they once did in the past.

It is very much easier, more tempting, and very damaging to diffuse practices of cutting down mixed forests and planting a mono-culture crop of tropical pine, or whatever, for industrial use, or even the international market under our export-led growth strategy. The temptation must be avoided of laying down one type of strategy or technological emphasis. Each case must be judged by the yardstick of whether the technology or strategy chosen emphasizes direct community use and gain, rather than through market forces. This inevitably means acceptance of decentralized development with weaker elite control from the centre.

8. Does this mean a revolution? No, it only means a staged withdrawal from over-management. As proved conclusively by socialist countries, socialism like love is a sensitive plant that dies in treacherous soil. No changes will occur in the political structure, let alone the political culture of the people. The introduction of new technological and economic initiatives

within a changed sociological environment of real land reforms and support to the small peasant will certainly result in some social movement — but this will only move society from the position of a failed capitalist one to that of a less-failed capitalist society. The political structure within which this movement will occur will remain what it always was — an under-developing capitalist society. As for political culture, there will be even less disturbance within the heads of people.

9(a) The grand appropriate technology intervention we should leave to the west, where they can play around with rich toys, photo-voltaic panels to cool refrigerators, windmill turbines to heat houses, or whatever. I must make it clear that I am all for appropriate technology for the farmer. In fact, the Indian farmer is the greatest proponent of it, because that is what he uses. But his interests are only on use and production, not on publicity. This is where he falls out with the scientist and the minister. If the farmer is given enough elbow-room, we may find many a technological innovation coming out of villages.

9(b) The other strong initiative of "Informal Education" also we should leave to those socialist countries that are young enough to think beyond slogans, such as, may be, Zimbabwe or Mozambique. The farmer does not need us to tell him that he is poor and oppressed. He learns this and much more from birth. We discover his poverty and oppression only after a Ph.D. and in middle-age. If the west or east do innovate anything, of course, we can be eclectic enough to adopt it.

10. The poor are economically weaker than us, because they are less powerful. The poor are less well organized because they are less powerful. The poor are ignorant because they are less powerful.

We have pounded them with our wealth, our power, our knowledge to maintain ourselves. We can no longer maintain ourselves, let alone them.

We are the last people to worry about the minimum needs of the poor. If we do not lean on them so much, they can meet their minimum needs, which is their constant concern. If we get off their backs, they may even meet their maximum needs, which is more important. This is their need as a people, as a society, for love, for social involvement, for creativity. At the nadir of our wounded civilization, we the elite are unable to perceive the completeness of our alienation, our fragmentation, our non-creativity. We are going to produce no miracles as we desire, we are no heroes as we imagine. Nor is the frenzied left going to find devils and villains amongst us. We are the debris of two collapsed civilizations — the Indian and the western.

So, in sum:

(a) Let us abandon the landlords.

(b) Let us give back to the peasantry their traditional independence from the elite (this is all the Chinese have really done).

(c) And let us support technologies and practices that help the poor survive, rather than inflate our profits.

The path of ruling class elite, and hopeful regeneration sometime in the future, shows us no other options. What we should do, as the British did 35 years ago, is to DE-COLONIZE THE POOR. We may still walk away with some honour.

INTERDEPENDENCE BETWEEN SCIENCE AND TECHNOLOGY AND THE SOCIO-CULTURAL ENVIRONMENT: THE INFLUENCE OF GENDER-RELATION

Maithreyi Krishna Raj *

Science and technology as a social activity is inevitably related to the socio-cultural environment. In Third World countries, science and technology is important as a major instrument of development. The questions that have pre-occupied us have been: What should be the priority areas? How do we build indigenous technology? How do we carry the results of laboratory research to the farm and the factory? A fair amount of literature exists today on these issues. Two recent additions have been the adoption of appropriate technology and the propagation of a scientific temper. In developing countries, the obstacles to the transformation of a traditional backward society into a scientific and productive society are felt to be lack of resources and difficulty of assimilation. For assimilation to take place, according to this view, the necessary ingredients are 'motivation' on the part of receptors and 'communication skills' on the part of the initiators. Social relations do not enter the discussion or analysis as part of the matrix in the generation of scientific advance itself. Even the popular science movement, no doubt a welcome and significant social movement, nevertheless has the philosophy of 'taking' science to the people, not involving people in the very generation of new knowledge. Similarly, the emphasis in appropriate technology is on providing an alternative to the people. The development of technology takes place in the laboratories and the people must be taught to see its advantages. The people are not visualized as participating in the generation of technology. Given mass illiteracy, how is this possible, the experts could say and they are right, but do we regard people's participation even as a goal? The consequences of science by scientists alone are immediately and dramatically visible in the area of health and medicine, though they are not so directly obvious in other instances. The bias in the system of medicine is often for all to see. That the system in its design and its priorities ignores the needs of the people in general and is instead geared to meet the requirements of a few is acknowledged. It may be argued

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that science and technology in general is directed to the improvement of overall productivity and welfare "society" and if the benefits happen not to reach the poor, it is a distribution problem, a case of bad conscience, to be remedied by some moral cleaning up.

If in the development of science and technology as a whole, social relations are not perceived as a fundamental issue but as an unfortunate aberration that nullifies otherwise pious intentions, gender-relations are not even seen at all as relevant to the issue. In recent years, considerable data have accumulated to show that development has left women disadvantaged, but this unpleasant fact is usually regarded as evidence of a past backlog of backwardness for women and time it is hoped will eventually bridge the gaps wherever they are. Will it really?

The present paper examines briefly the ways in which gender-relations influence the development of science and technology in Third World countries. The disadvantages that women face arise not from accidental events, but are the result of a systemic-bias of the social structure. Gender-relations create this bias in two crucial ways: the sexual division of labour and the power relations between the sexes within the context of the particular mode of production. Both these sets of relations are interdependent. What kind of allocation of tasks is done between men and women also determines who controls what and why. Sexual division of labour is not a convenient arithmetical device nor a straightforward biological imperative[1].

It is a complex system of hierarchy. To be specific, what kind of roles women have, whether they are recognized and whether they are rewarded have much to do with women's position in society. They have as much to do with whether science and technology reaches women and if it does, in what ways. It is the contention of this paper that (i) because women are not recognized as producers, the impact of technology on women is often negative, and (ii) even when technology is extended to them as non-producers, it is not necessarily advantageous to them, because they are thereby fulfilling priorities other than their own.

SCIENCE AND TECHNOLOGY AND GENDER-RELATIONS

The impact of science and technology within the context of gender-relations in Third World countries can be examined in the following ways:

(1) Do improvements designed for common welfare (men and women) reach women? Who appropriates them?

(2) If a technology 'reaches' women, do they have a net benefit or a net loss?

(3) Whose needs are met in designing innovations? Are women's work, women's needs perceived as worthy of attention?

(4) Who designs research and innovation?

(5) Is there bias in science itself, not merely in the application of it? For example, what kind of data are selected as evidence? How are data interpreted?

This paper hopes to illustrate the above five kinds of impact through citing field data wherever possible. It is not practical to make a comprehensive catalogus of such findings, but examples are used here as illustrations.

DO INNOVATIONS DESIGNED FOR THE IMPROVEMENT OF COMMON WELFARE REACH WOMEN?

Lack of appreciation of the key role of women in agriculture has resulted in the exclusion of women from new training programmes. Despite the fact that women spend on an average one-third of their day in farm activity, their participation in training programmes is marginal. Data from West Africa[2] show the relative participation of men and women in agricultural extension services:

	(Percentages)	
	Men	Women
Agriculture	85	15
Animal husbandry	80	20
Cooperatives	90	10
Arts/crafts	50	50
Nutrition	40	90
Home science		100

The situation in India is not different, though recently some efforts have been made to include women[3]. Not only did the women not directly benefit from access to new knowledge, but the increase in family prosperity did not always result in lighter work burden, improved nutrition, health or welfare of women". New technology often brings more cash income in the hands of men and the way men spend their income is not always for 'family' benefit but frequently for personal prestige. A common observation from all these studies is that men buy transistors and wrist watches rather than improve food availability for other family members or acquire other services that can reduce women's drudgery. Similarly, opening up of educational facilities does not lead to better education for girls (There are plenty of statistics to show this)[5].

ARE WOMEN NET LOSERS OR NET GAINERS?

Technological change has led to net losses for women. Both macro-level data and micro-level figures lend support to this. Employment opportunities particularly have been unequal for men and women; worse, women have

lost many of their previous occupations and if at all reabsorbed in new occupations, such jobs as they get in them tend to be of lower skill, lower paid jobs. The exception is for educated women who have gained better opportunities. During 1872-1971, time series data record negative impact on women due to changing technological structure of industry[6], which led to erosion of women participation in the vital income and wealth producing sectors of the economy. While many jobs done by women were eliminated, they had very few opportunities for entry into new occupations in industry during this entire period[7].

Detailed analysis of different industries also shows the displacement of women when technological change takes place (coir, cashew, fishing, spinning, etc.)

Given a sex-wise division of labour, women's participation in limited areas ensures their eviction when a change in technology takes place. This is very clear in West Bengal, where women were predominantly spinners, while men were more involved in weaving. When most of the tasks allotted to women are of the repetitive kind, they are more vulnerable to becoming redundant with the introduction of machanisation.

Technology not only displaces women completely, it often alters the division of labour between men and women in ways inimical to women whose activities are altered and, of course, determined by the existing gender-relations[8]. All over Africa, introduction of cash crops cultivations. If women into subsistence level, less productive, food crop cultivations. If new land is cleared for cultivation, women have to do more transplanting and weeding. In the Green Revolution belt, introduction of technology increased the work burdens for women, even for those not involved in farm activity, because they had to cook meals for more farm labourers[9] Dairy schemes add to the work for women in cleaning cattle sheds and tending the animals. Children's schooling may, by altering meal-serving patterns, make for extra work burdens for women. In the villages where men began commuting to the nearby city, the men preferred carrying chapattis. The women had to change over from bulk rice cooking to the more tedious chapatti making chore. More than in any other way, the introduction of technology, whether in a rural area or a backward area, places men in the advanced sector and retains women in a traditional or less productive, technologically backward sector, so much so one economist calls the women's sector as the periphery in relation to the men's sector[10]. Monetisation makes available to men greater access to cash than women. When the domestic unit, once a consumer of its own product, becomes a seller in a market situation, this acts as a catalyst to economic relations within the family unit. The individual who gains access first to means of higher productivity emerges the seller and thus gains the right to appropriate the cash earnings. The production relations between the sexes are modified to the detriment of women who are the focal point of

family welfare, producing the basic requirements to sustain life and transferring and delivering them to the point of final consumption.

Both in Africa and in Asia, women played a key role in marketing; they were active in village markets and also in many types of informal barter systems[11], but the advent of large scale marketing generally reduced women's role, because women were not free to move out of the village, were not thought appropriate for driving trucks and could not get access to institutional credit, banks and other market related services. This arrangement does have serious implications, because in an increasingly cash economy, this robs women of direct control over resources and increases their dependence on men.

WHOSE NEEDS ARE MET IN DESIGNING INNOVATIONS?

Are women's work, women's needs perceived as worthy of attention? Whether it be energy issues, environmental issues, such as housing or health issues such as nutrition and medical care, women's needs are met inadequately, if at all. Women's needs for potable water, lighter cooking time, fuel needs and renewable sources of energy are greatest. Inadequate provision for these has a direct consequence for their health. Their need for security, safety, privacy and prevention of fire hazards in environmental planning is rarely taken account of at both family and community levels. Absence of sanitary facilities closer home for women restricts their trips to hours when privacy can be ensured. It has been shown that this results in increased incidence of kidney disorders and increased possibilities of infection, leading to gynaecological maladies[12]. Where innovations are introduced, they are not always appropriate for women. Standing platforms for cooking increase the strain on back muscles and make the cooking space inflexible[13].

Similar examples can be cited from different areas. There is the case of the community biogas plant installed in a village in Etawah district of UP[14]. The timings given for cooking were 8 am to 10 am and 6 pm to 8 pm. This was not suitable for many rural women who have to be in their farms before 8 am or who have to leave behind young daughters alone at home to get to the community gas centre. It was also felt that the gas was unsuitable for cooking of dal, slow boiling of milk (done traditionally to preserve milk) or roasting of bajra chappatis. When women cook on a slow fire, they generally attend to other chores simultaneously. Appropriate technology apart from generating social readiness for its assimilation must enable the shaping and changing of social environment in ways that will facilitate a genuine transformation of rural life.

There is another telling example : the wood saving stove[15]. Innovations where no immediate monetary benefit is seen may not be perceived by the rural family as a priority, particularly where decisions are made by

men. The smokeless chulha's indirect benefit in the improvement of women's health may not be a "felt" need for the men in the family. Even otherwise, in this case where little wood is bought, the saving may not occur to even the women as necessary. The stove also required spare parts that increased the need for cash for each family. Sometimes, a traditional device serves multiple needs. The smoky chulhas kept the roof of the hut dry and free of termites. When a new technology replaces an old one, it must serve the multiple needs in the way the earlier device did.

Likewise, the current debate on forest policy has underlined the women's role in the fuel and fodder system of rivalries. With the disappearance of tree cover in many places, rural women have to walk 10 km a day to fetch wood against the 1 km barely 15 years ago. It is important to look at energy requirements, within the context of women's roles and responsibilities[16]. Women pound grain, but when grain mills are set up it is men who operate them; women fetch water, but when hand pumps are installed women are not given the responsibility for their maintenance[17].

Food processing involves threshing, cleaning, drying, dehusking and milling. Of the total human hours spent on these tasks, 70% is contributed by women. When all agricultural activities were analysed by sex in a village study[18], it was found that even within the traditional technology available, men's activities had the benefit of better tools than those of women. Men used bullock carts, rollers, storage bins, whereas women used sickles, wooden sticks, sieves, baskets and gunny bags. Though women's role in maintenance and repair of not only tools but houses was considerable, they did all of it manually, washing, repair of winnowing trays, baskets, brooms, plastering mud walls, cleaning the floor several times a day and so on. Thus, the sex-based division of labour leaves women with the major part of the work required for the daily supply of food and with the responsibility for maintaining an adequate nutritional standard in the diet; but they have to rely mainly on their own physical labour. Even for carrying out what are regarded as "traditional roles" women have less resources accessible to them.

WHO DESIGNS THE INNOVATION OR TECHNOLOGY?

The contributions of women as producers is not taken into account, because their roles in society are perceived as non-producers, because the innovators are rarely women themselves. In the ASTRA study (see Appendix 1), there is clear evidence of the disproportionate allocation of work between men and women and the enormous burden women carry[19].

Yet, no calorie cost studies estimate the actual calorie requirements of women, taking into account their work burden; instead unrealistic nutritional norms are set by men under the presumption that much of women's work is sedentary. According to Srilata Batliwal's estimates[20], these aught to be 2505 calories for adult women against 2473 for adult men. Women

do 53% of the total work in rural areas, while men do 31% and children, 16%. Most pregnant and lactating women get a little more than one-half or even less of the recommended dietary intake and during a woman's 30 year reproductive span, as many as 16 years are spent in pregnancy and lactation.

In a society supposedly idealising "motherhood", mothers are most inadequately provided for (see Appendix 2). Our maternal mortality is one of the highest in the world and the applied nutrition programme, ostensibly geared to pregnant and lactating women, is extremely scanty. Even if 40% of our expectant mothers are to be cared for, we would need three times the present level of expenditure. In addition, the design of these programmes defines women in terms of biological vulnerability rather than economic vulnerability.

Even when women do receive special attention, existing gender-relations influence their outcome in a way that lends additional strength to the male bias of the social relations. Family planning programmes and contraceptive research cast women as the main risk bearers. As extreme instance of this is the preference for female sterilisation in many regions, even though the risk entailed in male sterilisation is practically zero (see Appendix 3).

Is there a bias in science itself? The way data are collected and interpreted is influenced by the way women's roles are perceived. Extensive discussions on these are reported in books dealing with sexism within science[23]. Closer home, when data are carefully collected, misconceptions are exposed. The nutritional norm set without regard to women's heavy work burden is one example. The definition of skill in our economy is often irrational. Many types of work women do are regarded as unskilled, while types of work that men do are rated higher. No empirical verification is done. In a study on gestation periods of male and female births with a sample of 1028 births, the researcher found no significant difference between male and female births contrary to medical opinion that female births have longer gestation.

Information and research on women's lives in areas other than fertility studies are not undertaken. Even today, information on some of the basic points governing the physiology of reproduction for women under Indian conditions is not available. More significantly, the socio-psychological implications of physiological events in the lives of women have not received the necessary attention in research. In the Mysore study by Brita Brandzaeg[25], girls after puberty were never seen outside the houses even at younger ages; she did not find girls playing outside, whereas boys usually were seen playing. This is not an uncommon phenomenon. The consequences for health of girls because of social restriction have been to deprive them of adequate leisure, fresh air, outdoor exercise and social exposure and many vital learning experiences.

Inequalities within the scientific establishment are expressed in four ways: (a) under-representation of women in science, (b) under-representation or rather near exclusion of women from policy-making bodies at all levels, (c) unequal opportunities for women scientists and technologists because of their statutory supplementary responsibilities at home, and (d) inadequate provision of facilities for women to be mothers as well as scientists.

There is a certain irony in the fact that science which has of late discovered the evils of maternal deprivation and bottle feeding, etc., is itself not able to allow its practitioners to take remedial steps[26].

INCREASING WOMEN'S PARTICIPATION

There are two levels at which this needs to be done. At one end, the role of women scientists should be strengthened and widened. The Planning Commission in its Sixth Fiver Year Plan has made important recommendations for modifying or moulding personnel policies with regard to women that can aid this process.

At the other end, there is the issue of how science and technology can reach the masses of women. The main arguments in this paper have been: (i) their role as producers needs to be adequately recognised; (ii) they should be adequately involved in the process of generating technology; (iii) this can happen only if there is an attempt to build on their own social stock of knowledge rather than .providing totally new alternatives. The obstacles are the way work is allocated and the way their roles are perceived, and underevaluated. In an infant feeding programme in Mysore, when nutritive food packets prepared in the laboratories were distributed to women, there was not much response, but when a unit was set up within the village and the women were involved in the running of it, the response was far more encouraging[27]. The experiment became more successful when it showed women how to use their own knowledge and skills. These village women knew about the superior nutritive value of germinated green gram and malted ragi. Women have a fairly adequate social knowledge stock in the following areas:

(i) Food storage and short-term as well as long-term food processing.
(ii) Maintenance and utilization of water and fuel resources.
(iii) Life span health maintenance, including care of children and the elderly.
(iv) Production of household equipment, including housing construction.
(v) Maintenance of inter-household barter systems.
(vi) Maintenance of kin network and ceremonials, both daily recurrent events and crisis events.

Women are involved in many decisions of farm families regarding seed purchase, manure and equipment. They manage cattle, poultry and

bee-keeping. Such knowledge needs to be preserved and improved upon. Agricultural universities and home science colleges can play a useful role. In this connection "home science" should be relabelled as community service science, as recommended by M. Anandalakshmy of Lady Irwin College, New Delhi. The way social stock of knowledge can be utilized is illustrated by a research study that investigated women's own beliefs and ideas regarding their bodies and diseases[28].

When along with technological change, social infrastructure is made available to women in the form of education and public health services, and where women possess some measure of economic independence, they become capable of seizing new opportunities. This is shown by the Kerala experience when mechanisation of boats and ice storage replaced country crafts and older methods of fish processing[29].

Women must become equal partners at home and outside, if they have to share in the fruits of science and technology and if they are to contribute to the generation of new knowledge.

As for technical education for girls below the degree level, according to the Deputy Adviser, Labour, Planning Commission, there is no precise information on the number of girls enrolled. There were in 1980-81, 831 IITs with 192664 seats, of which 127 were only for girls, but since girls are also enrolled in other ITIs, no exact figures can be calculated from this (Annexure XVI-2, Report of the GOI/ILO/SIDA, All India Women's Vocational Training Seminar, Vigyan Bhavan New Delhi, 21-24 September 1984).

NOTES

1. *There has been a continuing controversy regarding the role of biology versus culture. Neither biological determinism nor cultural relativists can lay claim to ultimate truth. Anthropologists have long since exploded the myth of man "the provider", for throughout history women as food gatherers and food growers have played a dominant role. At no time did human society receive its major food supply through hunting. On the other hand, the cultural relativists' extreme view that all differences between men and women are culture determined ignores evidences of certain differences. What is important to understand is that these differences do not justify the enormous differences that are socially created. Biology only predisposes us to act in certain ways; it does not "determine" behaviour. Human variability and flexibility allow for a great range in behaviours.*

2. *Iftikhar Ahmed: Technological change and the Condition of Rural Women — A Preliminary Assessment. World Employment Programme Research. Working Paper ILO Oct. 1978.*

3. *Bina Agarwal: in Agricultural Modernisation and Third World Women – Pointers from Literature and an Empirical Analysis, Preliminary discussion paper for the Rural Employment Policies Branch. Employment and Development Dept. No Geneva. January 1981 gives a comprehensive review of studies in Africa, Latin America and Asia, including India. Our own study "Impact of Modernisation and Urbanisation on women in Wagholi – A village in Thana district" (1978-81) fully corroborates the non-inclusion of women. Here we found that two-thirds of the women's day was involved in farm work and animal husbandry, but not a single woman was involved in any training programme.*

4. *There are several studies "Impact of Development" that document this in India (e.g. Surinder Jetlay: "Impact of Development on Rural Women – a case study of Eastern U.P., ICSSR, 1979; Govind Kelkar: "Women in Post Harvesting Activities in the Green Revolution region, "U.N. University, Tokyo, 1981; Rekha Mehra: Neglect of women in India's Rural Development Programmes - Failures in Planning ICSSR, 1979).*

Indirect data on fertility and health status also show lack of impact on women's welfare.

5. *In Wagholi, which lies in a district in Maharashtra with the highest literacy in the state, incidence of school dropouts for girls was more than for boys, especially among the poorer households.*

In our survey of 9 villages in Udwada, South Gujarat, health statistics show marked variations between men and women. Corroboration is easily available from All India health statistics.

6. *Sarathi Acharya: Employment of Women and Men in India – A Historical Review, 1901 - 1951. Indian Journal of Labour Economics, Vol.XXII No.3, Oct. 1979.*

7. *Sarathi Acharya: Transfer of Technology and Women's Employment in India, ICSSR, 1979 (mimeo).*

Jaipal Ambannavar: Change in Economic Activity of Males and Females in India. Demography India. 42, 1975.

Asok Mitra: Implications of Declining Sex Ratio in India's Population. Allied Publishers, 1979.

Planning Commission: Women in Employment - 1901 - 1951 Government of India, 1958.

8. *(i)* *Iftikhar Ahmed: World Employment Programme, ILO, 1978.*

(ii) *Proceedings and Papers of the International Conference on Women and Food (mimeo).*

Vol.I. University of Arizona. Consortium of International Development. 1978.

9. *Bina Agarwal: Agricultural Modernisation and Third World Women. Study of Wagholi Village, Research Unit on Women Studies, SNDT University (mimeo).*

10. *Elise Boulding: Dualism and Productivity. Examination of Economic Roles of Women in Societies in Transaction. Seminar Paper, Mimeo. Colarado, Boulder, USA 1976.*

11. *SNDT Village Study op. cit.*

    Here we found women selling vegetables in the local markets, but bulk transport and large scale transaction were handled by men. There were many informal barter systems between households, quilt making for others, hiring out of vessels and so on.

    (ii) Leela Gulati's study of a fish vendor in her "Profiles of Female Poverty" (Hindustan 1981) also describes the confinement of women to pubhouse to house vending but large scale marketing is done by men.

12. *Asian and Pacific Centre for Women and Development "Environmental Issues Affecting Women with particular reference to Housing and Human Settlements", April, June 1980.*

13. *It has been estimated in a study by the Development of Preventive and Social Medicine, Nair Hospital, that more than three-fourths of burn cases are due to kitchen fires.*

14. *Nirlep Malhans and Kumkum Sanghera: Community Gobar gas plant – Case Study of 2 plants in Village Fetch Singh Ka Purva. Paper (mimeo) presented to National Conference on Women Studies, April 1981.*

15. *Bina Aggarwal: Diffusion of Rural Innovations: Some Analytic Issues and the case of wood Burning Stoves, Institute of Economic Growth, mimeo. Delhi, 1982.*

16. *(i) Business India: Fuel crisis in Rural India. 16-29 August 1982.*

    (ii) Sharad Kulkarni: Towards Social Forest Policy. "The Economic and Political Weekly", Vol.XVIII No.6, 5 Feb. 1983.

    (ii) Brita Brandtzaeg: Women, Food and Technology, A Village Study from India, University of Oslo, Oslo, 1982.

17. *Irene Tinkers: Energy Issues, Women at Work, ILO, No.2, 1982.*

18. *(i) Govind Kelkar: Women in Post-Harvest Operation.*

19. *ASTRA (Application of Science and Technology to Rural Areas), Bangalore. Rural Energy Consumption Patterns, 1980.*

20. *Srilata Batliwals: Rural Energy Scarcity and Nutrition – A New Perspective. The Economic and Political Weekly vol. XVII, No.9, 27 Feb. 1982.*

21. *Kathlean Newland: Why Do Infants Die, Science Today Feb. 1982. Leela Gulati: Marked Preference for Female, Sterlisation in 'Learning About Rural Women', ed. Sandra Zeidenstein, Pop. Council, 1979 (USA). Studies on Family Planning Vol.10. No.11 & 12.*

22. *Comparative estimates for 1977-78 in Maharashtra give disproportionately higher figure for tubectomy than vasectomy – almost five times as much – a reverse trend from that of earlier years.*

23. (a) *Evelyn Reed: Sexism in Science. Pathfinder Press, 1978 (USA) in discussions on primate social behaviour, preconceived notions and biases abound. There is no space in this paper to elaborate on these.*

(b) *Ruth Hubbard (ed): Women looking at biology looking at womenSchenkman Pub. Co. Cambridge. Mass USA. 1979.*

24. *Malini Karkal: Gestation Period of Pregnancy, Working Paper of the Inter national Institute of Population Studies, 1976 (mimeo).*

25. *Govind Kelkar: Women in Post-harvest operations.*

26. *Planning Commission: Committee on Sc. & Techn. (Nov. 5, 1980).*

27. *Brita Brandt: Women, Food and Technology.*

28. *Michele Goldziecher Sheolin: Assessment of Body Concepts and Beliefs in Learning About Rural Women. (ed) Sandra Zeindenstein, Pop. Council, 1979 (USA).*

29. *Leela Gulati: Fishing, Technology and Women, Part I, Working Paper No.155, Centre for Development Studies, Trivandrum, 1983.*

Table 1 - ESTIMATED NUMBER OF WOMEN SCIENTISTS IN INDIA (1975)*

Subject	Total stock (M+F)	Women scientists	1971 proportions
Agriculture	24,536	150	3.6
Botany	23,693	6,800	28.7
Chemistry	53,632	6,000	11.2
Physics	39,336	2,600	6.6
Mathematics	59,653	6,100	10.2
Statistics	8,769	670	7.6
Geology	9,300	90	0.9
Botany	22,514	3,360	14.95
Zoology	23,092	6,700	29.03
Psychology	15,745	7,100	45.72
Home Science	1,431	1,360	95.11
Other sciences	3,626	870	24.0
	2,85,327	41,800	14.6

Medical graduates	29,780
Post-graduates in medicine	8,160
Engineering graduates	3,100
Post-graduates in engineering	530

*All the tables included in this paper are taken from the Report of the Working Group on Personnel Policies for Bringing Greater Involvement of Women in Science and Technology, Ministry of Social Welfare, Government of India, New Delhi,1981

TABLE 2 - SCIENTISTS IN THE CSIR AT VARIOUS LEVELS AS ON 1.7.1980

Level	Total strength	Women	Percentage Total	Percentage Women
Director	24	--	0.6	--
Scientist (Dir.level)	7	--	0.2	--
Scientist F	48	--	1.3	--
Scientist E.II	88	1	2.3	0.6
Scientist E.I	376	5	9.9	31.1
Scientist C	1,137	33	29.7	20.4
Scientist B	1,197	65	31.3	40.1
Scientist A	756	47	19.8	29.0
Other Technical	189	11	4.9	6.8
Total	3,822	162	100.00	100.00

Table 3 - ISRO STAFF STRENGTH IN VARIOUS YEARS

Year	Women in Nos.	Women in % w.r.t total	Man in Nos.	Man in % w.r.t total	Total
1976	85	2.6%	2409	97.4%	2165
1977	69	2.9%	2292	97.1%	2361
1978	91	3.2%	2793	96.8%	2884
1979	139	4.3%	3100	95.7%	3239
1980	146	4.5%	3133	95.5%	3279

Table 4 - INSTITUTE OF TECHNOLOGY:STATISTICS OF FACULTY

	Men	Women	Total
Bombay	314	15	329
Kharagpur	464	7	471
Madras	340	10	350
Delhi	321	18	339
Kanpur	269	8	277
	1708	58	1766

Table 5 - M.Sc.ENROLMENT: SEX-WISE AND SUBJECT-WISE BREAK-UP 1979-80

Subject	Men	Women	Total	% Women to Total
Physics/Appd.Physics	6,363	1,406	7,769	18.09%
Chemistry/Appd. Chemistry	9,129	3,037	12,166	24.98%
Mathematics/Appd. Mathematics	7,051	1,880	8,931	21.05%
Statistics/Appd. Statistics	1,625	401	2,026	19.79%
Biological Sciences	475	219	694	31.56%
Botany	3,835	1,930	5,765	33.49%
Zoology	4,015	2,197	6,212	35.38%
Geology	623	298	921	32.35%
Home Science	--.	1,296	1,296	100%
Micro Biology	296	181	477	37.95%
Bio-Sciences	528	310	838	37%

Anthropology	202	154	356	43.26%
Others*	721	244	965	25.28%
Total	36,587	13,662	50,249	27.19%

*Includes Biometry, Criminology, Industrial Fisheries, Psychology, Genetics, Military Science, Marine Science, etc.

Table 6: RESEARCH ENROLMENT IN SCIENCE: SEX-WISE AND SUBJECT-WISE BREAK-UP - 1979-80

Subject	Total			%
	Men	Women	Total	Women to total
Physics/Appd.Physics	1,409	263	1,672	16.27%
Chemistry/Appd. Chemistry	2,179	586	2,765	21,19%
Mathematics/Appd. Mathematics	769	143	912	15.68%
Statistics/Appd. Statistics	236	35	271	12.91%
Biological Sciences	260	92	352	26.13%
Botany	1,234	481	1,715	28.05%
Zoology	1,068	384	1,452	26.45%
Geology/Geo-Physics	490	22	512	4.33%
Geography	173	90	263	39.22%
Home Science	3	64	67	95.52%
Micro Biology	70	27	97	27.94%
Bio-Sciences	167	81	248	32.66%
Anthropology	59	61	120	50.08%
Others*	327	71	398	20.35%
Total:	8,444	2,400	10,844	22.13%

*Include Biometry, Criminalogy, Industrial Fisheries, Psychology, Genetics, Military Service, Marine Science, etc.

Table 7: INDIAN INSTITUTE OF TECHNOLOGY: STATISTICS ON WOMEN STUDENTS

IIT	Year	B.Technical	M.Technical	M.Sc	Ph.D		
					Sc.	Engg.	Total
	1976	25	28		24	7	31
	1977	29	29		27	11	38
Delhi	1978	33	22		33	17	50
	1979	33	24		36	21	57
	1980	29	40		27	28	55
	1976	12	5	20	20		22
	1977	15	4	31	31		24
Bombay	1978	20	3	40	40		32
	1979	23	2	38	38		33
	1980	24	5	32	32		33
	1976	23	5	17		19	19
	1977	25	6	21			16
Madras	1978	30	8	35			18
	1979	24	10	26			13
	1980	21	11	46			27
	1976	13	--	--	12	4	16
	1977	7	--	--	10	-	10
Kharagpur	1978	1	1	--	12	3	15
	1979	6	6	--	4	1	5
	1980	6	12	14	6	2	8
	1976	9(include 5 years)	3	5(3yrs)			37
	1977	15(M.Sc. also)	7	9(M.Sc. only)			33
Kanpur	1978	17	7	11			32
	1979	23	6	11			34
	1980	26	5	15			25

Appendix 1 - Rural Energy Consumption Patterns*
(Human Energy Used)

Agricultural activity	Percentage distribution	
	Men	Women
Ploughing	8.4	
Transplanting	18.1	78
Weeding	17.0	79
Irrigation	13.0	--
Harvesting	16.3	--
Threshing	16.3	--
Winnowing	10.4	50.0
Sowing	--	41.0

Domestic Activities: For various activities such as gathering fire wood, fetching water, cooking, grazing, etc. energy expenditures by men, women and children were calculated.

Average Number of (hu)man-hours per household per year

	Agriculture	Fire wood collection	Cooking	Fatching water	Grazing
Men	799+159	33.5+8.1	0.7+0.8	2.9+1.4	51.3+4.4
Women	572+180	38.9+12.8	91.2+1.8	80.7+4.3	13.6+3.4
Children		27.7+8.4	8.1+2.3	16.4+4.9	35.1+6.2

Human energy in hours per household per day for all

	Men	Women	Children
Total (Omitting variations)	5.68	9.69	3.00

*Study conducted by ASTRA, Bangalore, 1980.

Appendix 2- Maternal Deaths per 1,00,000 live births in rural India (1972)*

Abortion	56.2
Ecalmpsía	46.2
Placenta praevia	30.1
Hemorrhage	30.1
Postpartum	36.1
Anemia	50.2
Abnormal presentire	28.1
Periperal sepri	56.2
Others	54.3
All	417.6

*Data from Report of the Foundation for Research in Community Health Workshop on Health Care, Nov. 1977.

Appendix 3 - Cumulative Reproduction Related Deaths Age 30 to end of Reproductive period*

Deaths per 1,00,000 women

No contraceptives	24.5
Legal abortion	92.0
Oral cóntraceptives	188.0
IUD	22.0
Diaphragms/condems	14
Tubectomy	14

FASHIONS IN SCIENCE, NATIONAL PRIORITIES, NEO-COLONIALISM AND THIRD WORLD FORESTS

Vinayak Purohit*

I. ILLUSION AND REALITY OF FASHIONS IN SCIENCE

After the Second World War, we have witnessed five distinct waves of fashions in science. First, the atom caught the world's fancy and the range of problems from nuclear energy through plasma physics to sub-atomic particles captivated our minds. Then came space travel, missiles and satellites. Everything related to space became our anxious concern. This was followed by microelectronics, computronics and robotics. The silicon chip became the new god. The fourth wave brought into focus cancer and heart diseases, and medical research related to these two problems became highly prestigious. The latest is alternative energy and environment, including all the interconnected aspects of prevention of desertification, reduction of pollution, conservation of wildlife, study of ecosystems, social forestry, solar power, wind and tidal energy, biomass utilization, and the like. Alternative energy and environment are currently the cynosure of all eyes.

Science fashions are only apparently haphazard, cyclical or superficial. On closer examination, the reality belies the air of electicism and cynical fun. The military - industrial complexes in Euro-America, particularly the USA, promote periodically shifts in S&T investments. Selected groups of scientists begin to receive billion dollar largesses. They find it possible to promote international conferences and seminars. Scientific journals open their columns to the newly-preferred institutions and scientists. New gadgetry develops in these areas. Some small amounts trickle down to the scientists of the ex-colonies. The latter, ever-anxious to receive the nod of neo-colonial approval, pick up the new waves falling on their career-sensitive antennas. Thus, a fashion in science arises, propagates itself, and then recedes.

Fashions in science are, in other words, real investment thrusts in advanced countries which have spread to the third world as feeble currents. For the developing countries, they are merely fashions, since they are

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unrelated to local urgencies. They are glittering opportunities offered to a few specialists in specific areas to travel abroad more frequently, to get published more easily and to build up careers more speedily. Fashions in science are really crumbs that have fallen off the imperialist table into the waiting and gaping mouths of the recognition-hungry in the developing world.

The latest craze for energy and environment has resulted in a fallout in several directions. National seminars are organized ranging from the simple one on "Energy" to "Five day international workshop on Paleoclimatological Changes." Then there are the pipedreams of ocean fired power plants, electricity from sun rays, energy from garbage and similar delectable visions which are wafted into the air as urgent, short-term, practical prospects. Crash programmes are put through, e.g., by the Centre for Science and Environment which prepared a report "The State of India's Environment: 1982" within just six months. Additionally, we are beset by hordes of wildlife fanatics who are willing to fight to the bitter end to save the life of a single wild-ass, and who are ever enthusiastic about making an air dash abroad at the cost of the World Wildlife Fund. The climax of this concern for energy and environment is reached when it is alleged that India is becoming tourists' favourite, though few tourists actually arrive, and in any case, spend very little in India*, and when Indo-U.S. plan for research is finalised including as a major programme, "the improvement of biological fixation of nitrogen, biological utilization of nitrogenous fertilisers and increase in biomass production for fuel, fodder and soil improvement."

cf. BRCC National Seminar on Energy, 19 December 1982, publicised through a supplement in Times of India of the same date; Interview of Dr. George Kukla, an American climatologist, in Indian Express, 24 October 1982;

"Ocean Fired Power Plants" by G V Joshi in Indian Express, 17 October 1982;

"Electricity from Sunrays" by Praful Bidwai in Times of India, 30 December 1982;

"Energy from Garbage" by Prem Shankar Jha in Times of India, 13 December 1982;

Anil Agarwal, Ravi Chopra and Kalpana Sharma, "The State of India's Environment: 1982" published in Sunday Observer, 19 September 1982.

"India Becoming Tourists' Favourite" Summary of unofficial study on 'Tourism and Its Power for International Goodwill and Economic Advancement" in Indian Express, 9 November 1982, Indo-U.S. Plan for Research Finalised", Times of India, 1 February 1983.

II. INDIAN PRIORITIES AND US OBJECTIVES

Alternative energy and environment are not matters of highest priority for India. Of the Indian GDP, only 27% is contributed by industry, and merely 14% by manufacturing. Thus, industrial pollutants, save in some small pockets, have not reached the levels they have attained in the US. Secondly, India has enough coal and lignite to last many centuries even if national consumption were to rise to four times the present level. Also, oil and natural gas are being discovered and tapped at a fairly accelerated rate, so that our output and reserves are both likely to be found fairly adequate in the course of the next decade or so. We also possess untapped hydro-electric potential. Thus, we seem to be fairly well off in sources of conventional energy, though some upgradation of coal may be necessary and some caution with regard to oil and natural gas consumption may be exercised. Thirdly, we have almost inexhaustible resources of thorium sands which could sustain a vastly expanded nuclear energy programme.

It is not our contention that we should not think of alternative sources of energy. We are merely urging that the priorities are different in the case of India. Our urgent problem is not to save wildlife, but to save human life. Our problem is not to develop energy from sun, wind, ocean or garbage but to utilize coal, oil, natural gas, hydel power and thorium sands to rapidly make available food, clothing, shelter, medicine and education to those millions who are living below the poverty line. Our priority is not to make India a tourists' paradise, but to accelerate India's industrialization by every means in the shortest possible time.

In the United States, the conditions are slightly different. American industry is spewing pollutants into the environment at such a frightful rate that already international protests have arisen about acid rain falling in foreign countries due to American recklessness. Secondly, the rightward moving Reagan administration is keen on dismantling the extensive and expensive regulations concerning pollution imposed upon private US enterprise by earlier Democratic administrations. Thirdly, US wants unfettered freedom for its multinational corporations, whether with regard to the mining of the sea bottom and of the Antarctic continent, or with regard to the exploitation of the environment. It wants American industry to be free to throw as much carbon dioxide as it may desire into the atmosphere. Fourthly, the US wants an internationalized regime to be established over third world forests, so that this green belt in the developing countries can continue to be utilized to the advantage of US private capital. American private capital is to continue to pollute that environment which third world forests are to continue to purify. Fifthly, the US does not want too rapid an industrialization of the third world, particularly of the middle tier "advanced backward" countries like India, since such a development would reduce the area of exploitation monopolised by US capital, increase competition in

respect of diminishing foreign supplies of oil and natural gas on which US industry is becoming increasingly dependent, and jeopardise the cold and hot war global plans of US military-industrial complex.

Naturally, for the above reasons, energy and environment possess almost the highest priority for the US. This is made clear by the document "The 5-Year Outlook on Science and Technology, 1981" transmitted to the US President by National Science Foundation on 26 January 1982.

III. IMPENDING ASSAULT ON THIRD WORLD FORESTS

The policy formulations purveyed by the above-mentioned "5-year Outlook" spell great danger to the independent nations of the third world. A west-oriented strategy is being advocated which should be identified and combated by scientists of the third world.

Extracts from the above-cited document "5-Year Outlook" are presented in Appendix A to this Note. The strategy in a nutshell is as follows :

> The US must be free to burn fossil fuels to any extent it chooses. Thus, its right to raise to disastrous levels the proportion of CO_2 in the atmosphere must remain untrammeled. However, since this is causing widespread ecological pollution, and unpredictable climatic changes, and since US needs tropical forest woods, for lumber and pharmaceuticals, and other essential products, it is necessary to devise international controls over the utilization of their own forest resources by third world nations under the mask of "the need to preserve tropical forests" and "the need to prevent desertification."

Instead of the international community laying down the parameters to the US, and forcing American industry to observe limits to which it can pollute the earth's atmosphere, and probably in anticipation of such an international demand, the US is trying to lay down the law to third world countries on the extent to which they can exercise their own sovereignty over their own forest resources, and is determined to force the third world countries to maintain unacceptably high levels of forestation in order to utilize those forests to clean up the environment that the US is massively polluting.

Considering the matter in a broader perspective, one realizes that there is a new dimension to the historical exploitation of the third world by the so-called industrialized nations. In the past two centuries, since the beginning of the Industrial Revolution in the middle of the eighteenth century, Euro-American industry has thwarted the industrialization of the third world, and in effect utilized their forests to clean up the environment that imperialist industries have been polluting with CO_2. America wants this exploitation of the colonial world to continue in disguised form even today.

But technological advances, and the development of productive forces in the third world, have brought to light the greed of the industrialized nations, whose operations are endangering the very existence of mankind on this earth. The well-known "green-house" effect is enveloping the globe, and "acid precipitation" has reached lemon juice levels in many regions. (cf, admission by the "5-year Outlook" on page 145.)

To be forewarned is to be forearmed. The third world must wake up to the new attack on its sovereign rights over its own natural resources. Tropical forests do not exist merely to ensure cleaning up of the environment for the greater profits of American industry. These forests are there for the benefit of the poor masses of the third world, and their rational utilization is the prerogative of their own planning authorities. Under the guise of "monitoring by international bodies", USA cannot be permitted to interfere in the national affairs of the third world countries.

We are now able to see in perspective, the intensified interest that US agencies have been evincing since the last few years in "social forestry" and "anti-desertification" drives in third world countries, particularly in Brazil, Sub-Saharan Africa, India and South-East Asia. Grants are pouring in, seminars are being organized, and "American Advisers" are offering expert advice to all and sundry about "scientific forest management". There is nothing "scientific" about the advice. It is strictly "business" guidance that is being purveyed in the interest of American industry.

The shibboleths of "international concern" and the need to "limit national sovereignty in the interest of the world community" are mere claptrap. No international community exists. Nor will it ever come into being without a change in the current pattern of world domination by rich nations of the world.

Through the UN General Assembly, the UNESCO, the FAO, and other appropriate forums, Indian scientists must demand the formulation of a World Environment Law, wherein it will be specified that pending the formation of a World Order and a corresponding World Planning Board, each nation be compelled to limit the amount of CO_2 that its industries throw in the atmosphere to the extent of the capacity of its own national forests to re-absorb the same CO_2. The World Environment Law should provide a progressive and swift reforestation of Euro-America, in order to achieve a global ecological balance.

In conclusion, the focus of concern is not tropical forests, but reforestation of Euro-America. The simple and equitable rule should be that he who pollutes must clean up. Thus, if American and European industries continue to spew out CO_2 at a prodigious rate, they must allocate sufficient land in their own countries to forest development to clean up the atmosphere.

Euro-American governments may be given 10 years to implement a crash reforestation programme. They cannot pre-empt the third world,

which is now entering the intensive industrialization phase. In the past, the imperialist depredations by Euro-America may have gone unnoticed, but henceforth, their activities which are menacing the world's climate cannot go unobserved.

A commission should be set up by the third world countries, under UN General Assembly control, that should assess the penalty in hundreds of billions of dollars, and more, which Euro-American states must pay annually to tropical third world nations for utilization of the latter's forests to clean up the atmosphere that Euro-American industries have been polluting beyond their own forest capacities. This fee and penalty must be paid every year till such time as reforestation of Euro-America reaches the points at which pollution levels are balanced by the absorption capacities of their own forests.

APPENDIX A

SOURCE: THE 5 YEAR OUTLOOK ON SCIENCE & TECHNOLOGY,1981

Transmitted to US President by National Science Foundation on 26 Janurary 1982

P. 3 : "Approximately 70% of all R&D in the United States is conducted by private industry".

p.16 : "Coal use is expected to increase throughout the decade. A number of industries are already converting to coal and natural gas from oil, and a good deal of attention is being paid to possible commercial systems that would allow cost-effective use of coal instead of oil in small manufacturing plants".

P.145 : "Coal use is especially problematic, because coal's low hydrogen to carbon ratio leads to the release of larger amounts of CO_2 for a given amount of heat than other fossil fuels".

P.18 : "The rapid disappearance of the world's tropical forests is leading to severe and far-reaching ecological problems. In the less developed countries, where most tropical forests are located, the disappearance also means the loss of a widely used resource. The United States relies on tropical forests as a major source of speciality woods and pharmaceuticals. A coordinated international effort on tropical forest research and management, greatly increased world-wide reforestation, and a detailed analysis of the political, economic and social consequences of reforestation are regarded as minimally necessary response to the problems".

p.63 : "Another important resource management problem requiring international attention during the next 5 years is the rapid disappearance of tropical forests that are being cleared in less deve-

loped countries to provide more land for agriculture and other commercial purposes. The continuous degradation of the world's tropical forests would accelerate the rate of extinction of tropical plants and animals and undercut needed water development projects in certain countries. It would also affect the availability of certain woods of importance to the United States and, by decreasing the amount of carbon reabsorbed from the atmosphere, could contribute to global changes in weather and climate. In December 1980, a US Government Interagency Task Force Group produced a report on tropical forests that defines several scientific and policy goals. Recommended R&D approaches include a world analysis of rates and causes of tropical forest loss, further study of ecosystem dynamics and forest management techniques, and major international programmes to inventory, evaluate, classify, and catalog unique forest plant and animal types".

p.64 : "Pollution of the atmosphere is a second transnational environmental problem requiring continued attention. There is marked concern in the Scandinavian countries, about the effects of pollutants from the United Kingdom, and there is some evidence that acid rain from the United States sources may be causing ecological damage in Canada. Therefore, the transnational atmospheric pollution problem requires focused attention and no doubt will be discussed a great deal during the next 5 years.

.... Increasing atmospheric concentrations of carbon dioxide from all forms of fossil fuel combustion, and perhaps, from deforestation could ultimately become the most important of all atmospheric pollution problems. It could be exacerbated by excessive deforestation and the resultant decrease in the capacity of the earth to reabsorb carbon dioxide from the atmosphere. Increased concentrations of atmospheric carbon dioxide could raise Earth's surface temperature sufficiently to shift world patterns of agricultural production and, by melting the polar icecaps, raise ocean levels appreciably.....

.............The nest 5 years could be critical ones for carrying out the research needed as a base for decision-making about how to deal with this problem".

p.118 : "There is reasonable consensus that world petroleum production will almost certainly plateau by the year 2000. By that time demand for petroleum elsewhere than in the US—particularly among the middle-tier countries of the third world — is expected to have risen sharply, resulting in increased competition and higher prices for supplies that are at best stable".

p.125 : "However, climatic effects (due to fossil fuel combustion) might be measurable as early as the first decade of the 21st century, and few analysts are prepared to dispute the argument that if fossil fuels-primarily coal-were to remain as the principal source of energy in the industrial countries, serious problems could ensue by the middle of the century".

p.140 : "Over the past 20 years, forest coverage of the world's land surface has been reduced from over 25% to 20%. At current loss rates, coverage is projected to drop to 17% during the next 22 years and to stabilize around the year 2020, when only about 14% of the Earth's surface will be forested. Much of the forest loss will occur in tropical forests in developing countries..... Such large losses will also have far-reaching effects that go beyond the areas where deforestation will occur.... Regional temperature and rainfall patterns could be altered, affecting agricultural production and water supply in areas far removed from the deforested lands and some plant and animal species would be lost and the total diversity of species greatly reduced. Additionally large-scale reduction in vegetation could seriously affect Earth's capacity to reabsorb carbon dioxide from the atmosphere.....Tropical forests are a major source of speciality woods, foods, and pharmaceuticals exported to the United States and other nations".

p.145 : "A high priority during the next 5 years will be to learn more about the details of CO_2 problem, so that information can be factored into long-range global strategy and environmental planning ..... A second, more immediate problem associated with and exacerbated by fossil fuel combustion, is acid precipitation most frequently identified as 'acid rain'..... Reports place current rainfall pH levels in certain parts of the eastern half of the United States....at acidity level of lemon juice. The two principal artificial sources of precursors to acid rain are oxides of sulfur and nitrogen, both of which are products of the combustion of contaminants in coal and oil. Emissions of sulfur and nitrogen oxides can react in the atmosphere to form sulfuric and nitric acids, which precipitate out with rain or snow, sometimes hundreds and thousands of miles from the emission source. The acid precipitation can have effects on fish survival, forest growth, communities of aquatic organisms, biomass production, survival of amphibian species, and agricultural yields. Such effects are widespread in eastern North America and Western United States and are now recognised as major problems in Japan and Northern Europe".

APPENDIX B

(i) Source: World Development Report 1981
(From Table 7, page 146-7)

WORLD ENERGY CONSUMPTION 1979

Percent of world total	Group of countries	Population	Per capita commercial energy consumption (kg of coal equivalent)	Total national group consumption (Million kg of coal equivalent)
10.47	Low income countries	2,260.2	463	1,046,472.6
11.10	Middle income countries	985.0	1,125	1,106,125.0
3.71	Capital surplus oil Exporting countries	25.4	1,458	370.332.0
21.68	Non-Market Industrial Economies or Communist Bloc	351.2	6,164	2,164,796.8
53.04	Industrial Market Economies	671.2	7,892	5,297,110.4
27.65	Of which USA alone	223.6	12,350	2,761,460.0
100.00	TOTAL	4,293.0	2,326	9,986,836.8

Note: The "5-Year Outlook" admits that 81% of US energy consumption is from fossil fuels.

(ii) Source: Centre for Monitoring Indian Economy, Basic Statistics Relating to the Indian Economy, Vol. I : All India, September 1981, Tables 4.7, 4.8 and 4.9.

INDIA'S OIL & NATURAL GAS PRODUCTION & RESERVES

A. Oil production, Proved Reserves and Number of Years Reserves would last

Year	Production M. tonnes	Proved reserves M. tonnes	No. of years reserves would last at current output level
1966	4.65	153	43
1971	7.19	114	16
1976	8.66	275	32
1980	9.40	366	39
1981-82	15.00*	1500**	100

Source: Table 4.8, sourced above

*CMIE estimate given in Table 4.9, sourced above.

**Markovich estimate given in Table 4.7, sourced above.

B. Natural gas reserves	Proved reserves* M. tonnes of oil
Year	
1980	295
Markovich estimate	5,000

Source: Tables 4.7A and 7B, sourced above.

*1 million tonnes of oil = 1.167 billion cubic metres of natural gas.

DEVELOPMENTAL PERSPECTIVE

ON THE METHODOLOGY OF PREPARING A SCIENCE AND TECHNOLOGY PLAN

Dhruv Raina*

1.0 INTRODUCTION

In January 1981, a meeting of State Councils for Science & Technology was held at Bangalore, where a document 'On the methodology for preparing a science & technology plan for Karnataka' was drawn up[1]. The document discussed the linkages between the socio-economic plans and the science & technology plan. The scope of a State Science & Technology Plan was also discussed.

This paper further emphasizes some of the points raised at the meeting of State Councils for Science & Technology, in the light of NCST (National Council for Science & Technology) document on 'ASTP' (An Approach to the Science & Technology Plan) prepared in 1973. This exercise is not meant to be a polemic on the ASTP. On the contrary, it is hoped that a critique of the NCST document might help in clarifying ambiguities present in the document, and thus have the 'potential of transcending' its limitations.

Secondly, this paper does not concern itself with all the sectors covered by the ASTP; only a few aspects, which are supposedly of relevance to those of us working on state level S&T planning at the KSCST†. Consequently, the critique may appear rather narrow in domain.

Any methodology or approach which leads to some sort of implementation or action reflects the ideological footholds of that methodology because a methodology defines the system to be studied and what lies outside it, which aspects shall become the subject of consideration and which will be considered outside its scope. And since there is no isomorphism between a relation among things and a relation among people or social groups, any methodology of planning involving social groups cannot be strictly scientific in the classical sense but is political[2].

To begin with, we shall see what ASTP has to say about the choice of techniques, the organizational set-up that it envisages and its purport.

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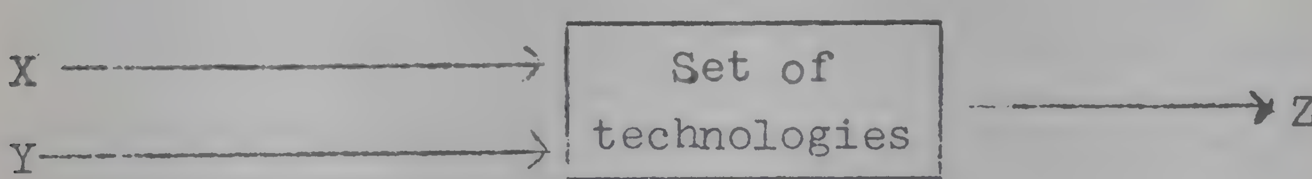
†However, the views expressed here are not necessarily those of the KSCST.

2.0 CHOICE OF TECHNIQUES

The rationale for the transfer of technology seems to be that since it is time-consuming and uneconomical to reinvent technologies, the developing countries will have to perform a quantum jump[3]. Imported technology, often enough, displays its inappropriateness, in the context of the evolution of the developing countries (DC's) and the less developed countries (LDC's). For example, these countries are often confronted with the dilemma of choosing between an energy/capital intensive technology and a labour intensive technology. The need for criteria for choice of techniques is thus imperative.

It is hoped that indigenous research in 'appropriate technologies' and a well-defined choice of techniques will serve as an effective deterrent to agents of foreign domination[4].

The two factors which play a dominant role in the choice of techniques are the labour to capital ratio and the time taken for a transferred technology to become functional[5]. It is thought that a suitable manipulation of these factors will augment socio-economic returns. The model seems to be of the following form:



X = Labour/capital ratio; Y = Gestation period

Z = Socio-economic returns

These criteria suggest that the optimum fixation of X and Y will, with the passage of time, pay off socio-economic dividends. The point behind the entire exercise is to maximise X and minimise Y. If this model is accepted *per se*, the ASTP recommendation of a suitable technology mix follows.

There are two major flaws in such criteria for the choice of techniques. First, it inadvertently rules out a whole host of societal and environmental aberrations which result out of the unsuitability of transferred technologies[6]. Secondly, the choice of techniques does not exclude 'foreign domination', since the instruments which act as 'effective deterrents to agents of foreign domination' are not written into the choice of techniques. In fact, they are not even implicit.

An alternative set of criteria for 'choice of techniques' have been formulated[7]. These, it will be seen, rectify the difficulties raised by the ASTP choice of techniques. These criteria may be summed up as:

(a) Does the technology cater to the needs of the neediest? Hence, a target group is also defined and in a limited sense gives the planning process an altered ideological orientation.

(b) Does the technology promote self-reliance? If it does not, then obviously the policy instruments do not preclude foreign domination.

(c) Is the transferred technology in harmony with its new environment?

Thus, the choice of techniques is related to environmental and societal factors.

However, there remain some questions, which are not posed in the ASTP document, and are relevant to any S&T plan, since they supplement the role of the choice of techniques. What are the factors that make a technology acceptable? If this were known, then it is imperative to ask the uncomfortable but not so futuristic question, as to how the equations between a society progressing towards self-reliance and the dominant technological groups change?

3.0 THE ROLE OF SOCIAL SCIENTISTS IN THE PREPARATION OF AN S&T PLAN

In addition to circumventing the limitations of the ASTP 'choice of techniques', the alternative criteria for 'choice of technology' envisage a larger role for social scientists. This was not so with the NCST, which had on its committee 'an economist and a technologist' as members. Consequently, the NCST 'approach' document seems to be soft-pedalling the role of social scientists.

To an extent, the onus for second class citizenship accorded to social scientists is due to themselves. In their overemphatic attempt at aping sciences, they have missed out the role of important historical forces which influence societal evolution.

There has since emerged a determinist tendency to look upon technologists and scientists as the providers of hardware solutions to societal problems and social scientists as providing software solutions. But the innocuousness to this attitude is evident when viewing the efficiency of, say, health care and management systems in this country.

The failure or inefficacy of these health care systems is seen to be due to the paucity of organizational and medical facilities. But the case of Kerala, indubitably demonstrates the important role of education and political will in the success of health programmes.

As was stressed in the last meeting of the State Councils, the linking of state S&T plan to the state socio-economic plan will render planning a more relevant exercise. In such a case, however, social scientists will have a larger role to play, since they do not merely effect a nexus between the S&T plan and the socio-economic plan, but may also have to set down equations of constraint both in the choice and transfer of technology.

4.0 RESOURCES AND ENERGY MANAGEMENT

Talking of resources and energy management, the ASTP document views the elimination of skewed urban vs rural growth through the effectual mobilisation and management of human resources. This can be done only through the fullest application of scientific and technical knowledge[8].

This seems to be a rather myopic view of human development, which can arise only from auto-centric considerations that scientists are best qualified to handle the 'mobilisation and management of human resources'. Managing resources scientifically is quite different from the mere application of scientific and technical knowledge. Planning for science and technology, when viewed as an exercise in resources and energy management, is an interface between the available fund of scientific and technical knowledge and resources management.

Resources and energy management will not merely entail the discrete and systematic management of energy sources. It will also involve a commitment as to which class and socio-economic group gets how much or how little[9]. To reiterate a point made earlier, any planning process committed to development and fulfilment of human needs will have to involve social scientists, who have far more than their conventional role of organizational scientists to fulfil.

5.0 COMPONENTS OF THE S&T PLAN

In this section, we will ask how and to what extent it is relevant to talk of a science and technology plan. ASTP demarcates three components of the S&T plan: those for basic science, applied science and technology.

Among the difficulties encountered in planning for science and technology are the large gestation periods involved in R&D projects. In most cases, the required solutions to R&D problems in science and technology emerge well after the social dimensions for which the plan was drawn have changed significantly. Hence, the need for linking the socio-economic and perspective plans with the S&T plan. These linkages should be flexible enough to effect changes from one plan to the other -- a process of simultaneously updating the socio-economic (SE) and the S&T plan.

The difficulties in planning for each of the three components of the S&T plan vary. To begin with, the problems posed by basic science are universal. And solutions to these problems emerge when the time is 'ripe enough' for them. Theoretical physicists have been working on a unified field theory for over 30 years — and a definitive theory is still to appear. It is, therefore, difficult to plan for basic science, since the time spans well exceed those of the S&T plan and at times even the perspective plan.

The situation with applied science and technology is quite different. There are two aspects to applied science research. One set of problems

result from the advances in basic science. The other set of problems are thrown up by society, and utilization of the results of basic science. Problems of the latter nature are usually region specific. Secondly, the time scales involved in most applied science researches are much shorter than those for basic science.

And finally, technology deals with the available fund of knowledge from both the basic and the applied sciences. A technology plan will relate to the adaptation and optimisation of already known processes, and concerns itself with the demonstration and diffusion of technology. The problems arising here are invariably region specific. And it is only here that it is strictly possible to speak of a plan with less caution.

From what has been arrived at in the above paragraphs, it should follow that a basic science plan, in whatever sense it may exist, may be coordinated centrally, since researches in these areas are more general, with little or no local character; the focus of basic science research shifts from one S&T plan to the other, depending upon the state of science in the international sphere.

The applied science and technology components in the S&T plan have to be viewed with lot more care. Applied science research resulting from advances in basic sciences may be subsumed under the category of basic sciences. The rest of the paper will concern itself with the latter variety of applied research problems, viz. the region specific problems. As and when solutions are found to the problems in the applied science category, the way for work in the demonstration and diffusion of the results of applied science as technology is paved. There is a dualistic aspect in planning for technology. A technology plan may push centralized schemes, e.g. the setting up of a steel plant, or the erection of wind mills across the lengh and breadth of the country. The plan may also promote more regional demonstration projects.

For an S&T plan to be immediately relevant to societal needs, it appears imperative that more R&D and demonstration projects be carried out in very locale/region specific areas of science and technology. For this to happen, we will have to descend to a lower level, i.e. to the state S&T plan, which will in turn have to be linked to the state SE plan.

6.0 NATIONAL AND STATE LEVEL INSTITUTIONS

The promotion and diffusion of relevant R&D will mean emphasizing R&D in regions where problems are posed and ought to be tackled. We will now have a look at what the ASTP says on its mechanisms for project selection and its consequences.

The ASTP document acknowledges lack of system in the selection of projects — the system being really arbitrary, since extraneous considerations come into operation which are in no way related to the 'require-

ments of the national economy'[10]. It is not truly germane to ask the question if the systematization of the project selection procedure would radically contribute to the successful implementation of the S&T plan — since there are additional constraints which tilt the project selection mechanism.

'The overall funding of scientific research', according to the ASTP, 'has been decided more by the absorptive capacities of the agencies and institutions concerned than by considerations of economic and social importance'[11]. It is but redundant then to proclaim that the S&T plan has little relevance to the socio-economic plan. Secondly, whatever ideological orientation the plan might have possessed is reversed in the implementation of the plan.

When factors like the 'absorptive capacity of agencies and institutions', 'standing of heads of agencies', 'factors external to the complexity of technology institutes are capable of handling', are operant; a major chunk of funding will land up in institutions having high 'absorption capacities', which, as is obvious, is a function of the 'complexity of technology handled by various agencies'.

Consequently, most research in S&T is effectively being carried out at the institutes of national importance. Although this might prove salubrious for research in basic science, certain limitations will have to be expressed when it comes to region/locale specific R&D, and particularly technology/process development. Region and locale specific problems will eventually be posed at the state level (and at even lower systemic levels). The state level institutions ought to have facilities to arrive at solutions to these problems. If these facilities are lacking, then the national level institutions have to be resorted to. This often turns out to be the case.

When the bulk of research in S&T is being carried out at the national level institutes, the dynamics of scientific and technological development promote both the level of S&T and the 'absorptive capacity' of these institutions to the exclusion of the state level institutions. This results in a vicious circle, since the technology gap between the national level and state level institutions continues to widen with every S&T plan. Due to the better facilities available at the national level institutions, researchers from the state level institutions naturally gravitate towards the national institutions, thus propagating the vicious circle. This has a telling effect on the standard of the state level institutions.

7.0 IN LIEU OF A CONCLUSION

What has been suggested in so many pages encompasses five or six points.

(a) Whether or not it is accepted, the ideological components in any planning process are manifest.

(b) The criteria for choice of techniques suggested by the ASTP document are quite ambiguous, and cannot fulfil the objectives laid down

by it. An alternative choice of techniques which is formally committed to human needs and self-reliance will have to be mooted.

(c) The role of social scientists in the drawing up of the S&T plan has so far been minimal. Social scientists have a larger role to play than merely providing software solutions.

(d) For the S&T plan to be relevant, it is necessary that the S&T plan be linked to the socio-economic plan both at the national and state levels. This might promote the emergence of region specific problems.

(e) Thus far, project selection has not been determined by the requirements of the national economy, but by a variety of extraneous factors. The result has been the promotion of the national level institutions at the expense of the state level institutions.

(f) Most of the research in S&T is being carried out at the national level institutions, the state level institutions lacking the facilities to do so. However, a major chunk of project generation and the diffusion of technologies can be carried out only through the state level institutions.

REFERENCES

1. *See Annual Report of the Karnataka State Council for Science and Technology, Karnataka State Council for Science and Technology, Indian Institute of Science, Bangalore 560012, 1980-81, p.66-72, for details.*

2. *Guhan S.: Towards a policy for analysis. Paper presented at "Workshop on Public Policy Analysis", April 5-7, 1982; Indian Institute of Management - Ahmedabad.*

3. *An Approach to the Science and Technology Plan (ASTP), National Committee on Science and Technology, Department of Science and Technology, New Delhi, Jan. 1973, p.6.*

4. *Ibid., p.7.*

5. *Ibid., p.31.*

6. *For an interesting case study which supports this view see K. Srinivasan et al: The Orissa Aluminium Complex Points towards a Debate, Economic and Political Weekly Dec. 5, 1981, Vol XVI, No.49.*

7. *Reddy A.K.N.: Technology, Development and Environment - a Re-appraisal, UNEP, Nairobi, 1979.*

8. *ASTP, op.cit., p.24.*

9. *See Discussion on Session III, in Proceedings of World International Energy Symposium, 1980, in World Energy Production and Productivity; Ed. Robert Bohm and others, Ballinger Publishing Company, 1981.*

10. *ASTP, op.cit., p.19.*

11. *Ibid, p.18-19.*

USING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

V. B. Srivastava *

INTRODUCTION

That science and technology have turned into instruments of "power, inequality and exploitation" from promise of "happiness and plenty" is one of the striking features of their growth in world today. Something has seriously gone wrong; from being a tool of human salvation, modern science has gone on a path that threatens even the survival of the human race.

More than 50% of investments in R & D programmes are made to produce still more superior weapons of mass death and destruction in order to gain strategic military advantage over a political opponent. Such arms race events are not only sustained among superpowers, but are also induced among poor developing countries, which cannot simply afford this. The developing countries clearly suffer from poverty, hunger and malnutrition and require basic needs of life, viz. food, potable water, housing, education, clothing, health services, transport, etc. Since the poor 'third world' political, bureaucratic, military, academic and communication elite are readily accepting the 'western model' of progress and the role of science and technology in it, there has emerged a global system of control, hegemony, exploitation and repression—all in the name of fashionable modernism and the theory of progress. The 'acceptor' nations get poorer, whereas 'donors' get richer. Neo-colonial phase involves penetration by transnational or multinational corporations (MNC's) (making physical occupation of territory almost unnecessary), sometimes resulting in ravaging of the third world, and allurement of local elites into a multinational system of power, wealth and privileges. All this happens in the name of modernisation using science and technology.

Traditional fishermen of Asia, for example, are being forced out of their occupation by mechanized trawlers for making massive catches of shrimp and marine delicacies. These are processed and canned by giant ship-based or shore-based factories to tickle the palate of well-nourished rich people of industrialized "west". This massive fishing results not only in declining fish stock, but also decline in protein consumption by local people,

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who have no source of protein other than fish. Moreover, traditional fishing is found to be economically defensible, ecologically sound and employment generating.

To keep the giant machines of industrialized world running and to meet the insatiable desire for foreign exchange among third world elite hungry for imported luxuries and weapons, large scale mining for raw material is resorted to, forests are cut, fields flooded, rivers silted and farmers displaced from independent sources of livelihood.

In the name of earning valuable foreign exchange through, say, tourism, meagre resources are diverted to the construction of 10-15 storeyed luxury hotels and for extending runways for landing of latest jets overlooking the need of millions for housing. The same logic is used for exporting fresh vegetables, rice, meat, eggs or onions by declaring them "market surplus" while millions of children go malnourished. High pressure advertising and sale drives aim at colonising their minds as such to "hook" the most deprived people to buy latest electronic/entertainment and other consumer goods of doubtful social utility.

The developing countries traditionally produce a large fraction of world's raw materials, but control an insignificant fraction of international trade of finished goods. Market mechinations of developed countries lead to falling prices of raw materials, preferences and protectionism, costly loans, etc; coupled with craze for modernisation, they contribute to swelling formidable 'DEBT BOMB'.

The social and psychological aberrations witnessed in the first and second worlds due to modern science nd technology are no less calamitous. The "civilization diseases" — mental depression, heart diseases, cancer — are becoming common-place due to environmental pollution, and psychological stress/strain of life styles. Juvenile delinquency, sex, crimes, drug addiction are inexorably increasing. Introduction of robots in industry has led not only to rise in unemployment, but boredom in workers and sometimes conditions leading to drug addiction, a variety of neurotic and psychic distortions and suicides. Man's pursuit of modern science appears to have been challenged by his own growth, development, and fulfilment. Bertrand Russel in his book : IMPACT OF SCIENCE ON SOCIETY (pp. 120-121) has remarked, "We are in the middle of a race between human skill as to means and human folly as to ends". He concludes that "Unless man increases in wisdom as much as in knowledge, increase in knowledge will be increase of sorrow".

OPTION BEFORE THIRD WORLD

History has placed the third world today in a uniquely advantageous position. Advantage lies in the fact that the western experiment in developing societies through application of S and T has come of age, showing its good and ill effects. And these can be observed, analysed and new lessons drawn.

The 'underdeveloped' who are ready to catch up with "western model" of society, or those who have not travelled far on this path, may pause, rethink and possibly take corrective actions, i.e. restate their problems which generally involve optimum utilization of their manpower and natural resources to generate basic needs of life, through a suitable machinery.

INDIA

Developing countries like India also are today in this advantageous position. India is, however, different from many other developing countries in having a rich 5000 year old cultural and scientific tradition: its natural resources have not yet been fully exhausted or environment polluted. India, during Vedic times (1600-800 BC) had rich traditions in medicine, chemistry, physics, engineering, mathematics and astronomy. ATHREYA (600 BC), CHARAK and SUSHRUTA were popular in the field of medicine and surgery. Works like ARTHA SASTRA (300 BC to 100 AD) deal at length with the techniques of mining, metallurgy and refining of noble metals. DASAVATHARA STORIES dealt with concepts like "Continental drift" and GARUDAPURANA RASI CHAKRAS triangles outline the tetrahedral theory of solid earth.

In his book 'Discovery of India' (p. 626-27) Jawaharlal Nehru has said that 'Science has dominated the western world and everyone pays his tribute to it, and yet the west is still far from having developed the temper of science. It has still to bring the spirit and flesh into creative harmony. In India, in obvious ways, we have a greater distance to travel. And yet there may be fewer major obstructions in our way, for the essential basis of Indian thought for ages past, though not in its late manifestations, fits in well with this scientific temper and approach, as well as internationalism. It is based on fearless search for truth, on solidarity of man, even on divinity of everything living, and on free and cooperative development of individual and the species, even to greater freedom and higher stages of human growth".

"Our ancients believed in unity of nature, the unity of all life and even non-life. Their sayings and shlokas reveal the magnificent range of their vision". Contemporary scientific researches are now supporting this approach.

"Nature in the process of its creation has possibly experimented with almost all permutations and combinations of simple and complex molecules. Whatever was dysfunctional was rejected. There is nothing like WASTE in the delicately balanced kingdom of NATURE. The waste of one species is food for another".

The balance is maintained through control of population operating in the cycles of nature. Human-beings by their ability to control some of the natural forces (without understanding the complex cybernetic system of nature) disturbed the balance by creating linear chains of resource exploita-

tion, which are characterized by rapid generation of waste for which there was no readily available competent natural reprocessing system" (H N Sethna, Indian National Science Congress, 1977).

Modern age is called the scientific age. In previous ages, man was dominated by ignorance, superstition and fear. Knowledge destroys fear. The spirit of free enquiry, scientific temper and verifiable knowledge found expression as pursuit of truth in pure science, and the pursuit of its fruits, in applied science, with the laudable aim of (as Thomas Huxley called it in last century) "alleviation of human suffering". What is science? "Science is not wrapped up with any particular body of facts: it is characterized by an intellectual attitude. It is not tied down to any particular method of enquiry. It is simply critical thought, which admits conclusions only where these are based on evidence. We may get a good lesson in scientific methods from a businessman meeting some new practical problem, from a lawyer sifting evidence, or from a statesman framing a constructive bill, "as defined by J. ARTHUR THOMSON, a famous biologist. (Home University Library, Edition, INTRODUCTION TO SCIENCE, p.58).

OF VALUES AND TECHNOLOGY

Science is universal, its progeny — technology — is not. Both are, however, value generating processes. These processes affect the society profoundly in a complex manner, influencing social values of an individual as well as those of the society. Similarly, extension of the time dimension yields a paradoxical transformation of values. Technology can solve problems of 'empty belly' which are well defined, but not those of 'belly full' which are psychological — not of deficit but identity — and of cultural despair. (KARL E, SCHEIBE, IEEE, Trans. Nov. 1977, pp.566-571).

Indian philosophy takes an integrated view of man — not only his sense of values based on basic biological needs, but also of higher intellect and finer sense of values. "Everyday science is penetrating into regions formally marked as unexplored or unexplorable. Our sense of beauty is similarly ever pushing on its conquest. TRUTH is everywhere. Therefore, everything is the object of our knowledge" (GURUDEV TAGORE ON SCIENCE, Prime Minister Smt. Indira Gandhi, VISWA BHARATI, 21 December 1982).

Such a harmonious approach to development and a judicious use of science and technology based on well stated values — cultural and social — may well lead to a different R and D programme for a particular developing country of third world. The educational policies have to be relevant to the needs of society. The total scientific and technological efforts have to be so directed as to enable the economy to reach the optimal rate of growth for all sections of the society....... The world is indeed finite. However, land, soil, water and forests are replenishable, yet can be recycled and substituted. Alternative sources will be forthcoming. (Hari Narain, National Academy of Sciences, NAGPUR, 1979).

Planning may centre round developing a self-reliant man, at different levels of society and optimum utilization of our rich natural resources.

We cannot break away from our past. The future has to be a continuation of past. "I cannot deny my past to which myself is wed. The woven figure cannot undo its thread". (Louis Mac Nevice, BEYOND MODERNISM' BEYOND SELF. SK Ghose, 1982, Bibhai - Impex, P. Ltd., New Delhi, 1982).

"The future of earth depends on a change of consciousness.....we can then look forward to a society based on sacrifice and compassion, rather than on strife and ignorance ...... while we weren't watching, we have become dinasaurs again. This time it is going to be do - it - yourself extinction". (George Wald, ibid 1982).

FUTURE OF COMMUNICATION

Futurist Alvin Toffler forsees a culture evolving out of present chaos — a new order out of desperate humanity. " This new culture — oriented to change and growing diversity — attempts to integrate the new view of nature, of evolution and progress, the new richer conceptions of time and space, and the fusion of reductionism and holism, with a new causality".

The proposed "integration" of new view of nature, and follow-up actions on a commensurate scale from the present times itself calls for efforts to communicate with 'mind' straightway through well conceived doses of messages. Science and technology have placed gadgets for instant, worldwide communication network. These can be used. Before they can be put to use one has to take into account the diverse situations. One uses communication media judiciously to motivate and persuade peoples in different countries towards the "new culture".

The UN has declared 1983 as "WORLD COMMUNICATIONS YEAR". At present times, powerful media of TV and film could be advantageously used for checking the traditional exploitation of poor developing nations. Common ways and methods adopted in exploitation may be exposed. Increased awareness among the masses may hopefully lead to cessation of at least these practices. Mass communication may be designed for propagating a sense of mutual dependence and mutual understanding.

Time is a crucial factor for the developing countries at large and India in particular. World population stood at 4508 million in 1981, with more than half (2,625 million) living in Asia. (UN Demographic year book 1981). India has added 136 million people in the last 10 years (from 548 to 684 million). The rich are getting richer, whereas the poor are getting poorer, widening the economic gap. Effective motivations may turn the resources, human as well as material, towards a 'universal brotherhood', and convert this rise in population into an 'asset' that seems to have burdened our economy.

KARIMNAGAR PROJECT: A CASE STUDY OF INTERACTION BETWEEN SCIENCE AND SOCIETY

G. HANUMANTHA RAO *

The theme of this seminar sounds more like being of concern to sociologists than to scientists and technologists. Being a scientist, somewhat involved in rural development and transfer of technology, I wish to make a few remarks based on my own experiences in the Karimnagar experiment, in various sectors of development, like natural resources, roads & buildings, public wealth and sanitation, etc. I was, of course, directly concerned with survey of natural resources under the guidance of Dr. Hari Narain. The overall guiding spirit behind the Karimnagar Project is Prof. Nayudamma. Dr. Siddu took care of industries and Dr. Subbaraju and Dr. Dhir of CRRI were responsible for roads. Dr. Y.S. Murty of NEERI as Project Execuitve executed a number of projects dealing with buildings, water supply schemes, rural sanitation, housing, etc., with the help of SERC and CBRI. The Project in its initial stages had some resistance from public as well as government sources. But through constant persuasion and extention work, we could persuade the local people and government officials to accept our technologies.

I would like to list some of the experiments carried out by various laboratories of CSIR and then speak about the reaction of local people to these expleriments. Karimnagar district, a backward district in Andhra Pradesh, was adopted by CSIR in 1972 to apply S & T for rural uplift and betterment of people, both urban and rural. The Project aimed at achieving better results in various sectors of economy with the same financial inputs as are normally provided in their budgets.

Scientists from various CSIR laboratories were drafted to undertake surveys in the sectors mentioned earlier and they prepared project reports which were time-based with a long time perspective and progress, each short step adding to long-term progress and development.

It was visualized that scientific planning is stipulated with preparation of an integrated development plan based on a thorough study of the natural resources and the finances available for development. In an underdeveloped area, any development input can bring about some improvement, though not necessarily the best under the circumstances. It is only an integrated

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development plan which would ensure optimum results. It was emphasized that the various alternative strategies should be examined within the framework of information already available before fianancial inputs were decided upon. Some of the issues which could be discussed were:

(i) Is industrially oriented development plan the best alternative and what are the industries that could be most suited to Karimnagar?

(ii) Karimnagar being primarily an agricultural district what role could animal husbandry, agriculture, silviculture, and horticulture play in the overall development programmes?

(iii) How could the people of Karimnagar be involved in the plans and programmes and what were their basic needs?

Surveys of natural resources have been undertaken by NGRI with the help of IPI, Dehradun, Osmania University and Survey of India. RRL(H) has prepared a plan based on the availability of local resources and manpower. CFTRI, Mysore has contributed considerably towards agro-based industries like rice milling, storage of agricultural commodities, egg powder plant, etc. RRL (H) has provided technologies for special papers, straw boards, oil milling complexes, etc. CLRI provided necessary inputs for leather industry by demonstrating techniques and imparting training in curing and tanning of hides and skins for the manufacture of footwears. Similarly, other laboratories like CGCRI, SERC, CBRI and NEERI have contributed considerably towards induction of CSIR technologies. For instance, the existing roads in the district provide a road density of only 12 km per 100 sq km as against the national norm of 32 km. A comprehensive three-phase, blockwise plan for development of roads has been prepared by CRRI. Some roads have been built by CRRI in Pochampad Command area, PWD, etc. The overall social reaction to these experiments has been good, but for the unhappiness of contractors and engineers.

The idea of CSIR was to involve the following agencies in the implementation of the schemes:

i. Cooperative societies constituted by local people.

ii. Voluntary agencies which are already working in rural areas with missionary zeal.

iii. Semi-government agencies like KVIC, state and central government departments of planning and rural developments.

iv. Government agencies like Zilla Parishads, Agricultural Universities, State (Regional) Industrial Development Corporations, District Industries Centres, etc.

The term 'Integrated Rural Development' has been in the limelight for quite some time in India as well as in many other developing countries. There can be no two opinions on the urgent and vital need for the

optimal exploitation of our renewable and non-renewable natural resources. It is also widely agreed today that the systematic and scientific exploration of resources should be on an 'integrated' basis with the aim of socio-economic development of backward tracts with due regard to environmental conservation. Again, in countries with a high rural population, it is but logical to gear all efforts to the achievement of a significant improvement in the living standards of the people of the villages. Thus, the broad aims and aspects of 'Integrated Rural Development' are well accepted in 'general terms'. But when one comes to deal with the 'specifics' relating to the methodology and mechanism of planning and execution of 'Integrated Rural Development', viewpoints could be many.

For instance, there is a wide divergence in views even with respect to the 'unit of interest' to be taken up for integrated rural development. There are those who think that each village should be considered as a unit by itself and all the various inputs should be applied there. This approach is too 'simplistic', because the development of a backward rural region is a complex' process that cannot be achieved by merely supplying potable water, better seeds, fertilisers and pesticides, organising literacy drives, etc., in each village or some of the villages of the backward regions. This aspect should be considered in the light of financial resources that can be made available to the development planners, so that they can select the 'unit of interest' accordingly; in doing so at least two 'key questions' should be answered,: (1) Are funds available for development of each and every village? (2) If not, which are the villages that are to be selected for development with the available funds? It is in this context of evolving a sound strategy for 'Integrated rural development' that the need for systematic and scientific inventory of resources of a region as a whole becomes obvious. Data in the shape of resource maps accompanied by reports emanating from such an inventory should be used as the basis for identifying various 'areas' of uniquely different 'resource status and development potentialities'. The resources of a relatively large region of geographic area need to be categorised and mapped first at a high level (mega, meso or macro) and subsequently at 'micro' level based on the 'first level' resource map. In other words, the micro level map would serve as an objectively rational basis for selecting individual villages that correspond to unique 'Integrated resource units' which can be developed accordingly, within the framework of a regional resource utilization plan at the first level. The rural development work would then go systematically according to priorities established on the basis of resource status and potentiality taken in conjunction with socio-economic criteria. Otherwise, although community development programmes have been operative during the various plan periods for the development of the rural community, the transformation expected in our rural society for improving the standard of living has not yet materialized. One of the reasons for this failure could be lack of scientific integrated survey of natural resour-

ces of rural areas based on which the development plans could have been executed in addition to isolated schemes of health centres, block development programmes, as the latter became mainly distribution centres for seeds, fertilisers, etc.

Resource inventories are the starting points for 'Resource Engineering', which can be said to embrace 'exploration, exploitation and monitoring' for scientific resource utilization. Such inventories necessarily call for the evaluation of varied resources such as land, water, soil, minerals and vegetation by the respective subject matter specialists, with the ultimate objective of arriving at an integrated picture of the resource potentialities of a given project area. It is in this context that 'integrated surveys' have come into vogue.

The term 'Integrated Surveys for Development Planning' is described by Zonneveld[1] as 'Surveys that include two or more related disciplines requiring coordination, taking into account the reasons for which the survey is conducted'. He further suggests that the integration of data relating to various disciplines should be so organized that the result of the integrated survey is more than the sum of the data of the individual disciplines and that the composition of the survey team needs to be oriented to the practical objectives of a given survey. This indeed is the essence of a rational approach to 'integrated surveys' to be preferred rather than an attempt to assemble a number of experts of different disciplines and ask them to survey a project area jointly. In other words, it is not necessary that specialists belonging to various disciplines should operate concurrently in a survey area. Great importance should, however, be attached to the task of integrating all necessary survey data oriented to the production of maps and reports that would be of immediate help to development planners and decision-makers in achieving limited development objectives as quickly as possible.

It can thus be seen that the planning and execution of multidisciplinary integrated resource surveys call for flexibility in survey methodology, so that the data gathering task would be tailored to defined goals specific to the project of interest. This all important 'phase' of initial planning for assigning tasks for specified survey teams as also all subsequent activities up to the final 'phase' of formulating integrated resource plans need to be the responsibility of a very competent and experienced 'Project Manager'. Otherwise, energy, time and finances are likely to be frittered away in 'excessive survey activity' by many specialist survey teams, leading to wastage of funds, inordinate delay and non-pragmatic development plans. Such a Project Manager should ensure that all phases of 'Integrated Development' beginning from 'Inventory' to 'Final development plan formulation' are adjusted to the specific needs of each project area and its development objectives within a time-bound schedule. In some cases, available data could be used for some resources and these may be supplemented by surveys for obtaining data for other resources of the area not yet evaluated.

1. *Zonneveld, I.S. (1972) 'Land Evaluation and Landscape Science' ITC Text book.*

In other cases, particularly in backward regions for which hardly any resource data may be available, necessarily different apecialist teams have to be put on the job of soil, minerals, water and vegetation surveys. The Karimnagar district project is of this type, where geological, geomorphological, pedological and vegetation inventories had to be executed for arriving at an integrated picture of the resource status of the district.

As indicated in a previous section, integrated resource maps are needed in different scales for different levels of planning and execution of development activities. Four levels are recognised: mega, meso, macro and micro.

The 'mega' to 'micro' level integrated resource inventories are best prepared through the efforts of multidisciplinary specialist survey teams adopting modern multistage 'remote sensing' procedures, where convenient. The resource data are conveniently depicted on Survey of India base maps. The 'mega' and 'macro' level resource maps are best prepared using respectively 1:1000,000 and 1:250,000 Survey of India base maps and transferring data interpreted from satellite imagery. For 'macro' and 'micro' levels, airphotos in small and large scales are ideal for use by specialist photo-interpreters who adopt systematic air photo-interpretation combined judiciously with selective ground studies. The four levels may be collapsed into two or three levels, depending on the nature of the survey area, terrain and development goals. For Karimnagar project, the macro level has been chosen. The surveys were essentially based on air photo-interpretation techniques combined with selective field work.

To secure people's involvement in the development process, as a first step, the people for whom the programmes are meant have to be trusted. There should be no hesitation or diffidence on this score. In the present case, the 'people' will be the target groups, i.e. the 'rural poor' and the 'rural weak'. A recent experience of discussing their problems with the poorest section of the rural community, i.e. landless labourers, and those belonging to scheduled castes in some villages in Karimnagar District, can be cited to illustrate the point. The suggestions which came forth from these poor people were indeed most rational, implementable and such as would give quick results in a short time-frame as against the demands made by the affluent sections of the same villages.

Therefore, the new strategy has to take into account the past experiences gained through various programmes of rural development. Area programmes have to be meshed with beneficiary approach for the identified target groups, and the planning as well as implementation has to be by the people for whom the programmes are designed, with minimal involvement of the government or participation of outside agencies which should be limited to the role of catalyst. Even in this limited role, there is a risk. Quite often, the 'programme' dies out once the catalayst is withdrawn. Therefore, the role of the outside agency should be that of something like

a self-multiplying enzyme or 'starter'. The programmes are to be location specific, i.e. based on the local resources and basic felt needs of the people. Many backward areas of the country have a vast potential of local resources which have remained by and large unexploited. The area programmes should be based on optimum utilization of the local resources by purposeful application of science and technology, which is necessary to achieve the main objective of providing full employment to the people. Wherever necessary, appropriate technologies may be developed.

The vuluntary agencies can play a very significant role in helping the objectives of integrated rural development to be achieved. There are many voluntary agencies of long standing and repute which have been working in very difficult interior areas and have shown results which are not easy to achieve for a governmental organization.

The programme-contents of Integrated Rural Development would necessarily differ from area to area. The bane of various past programmes has been a 'single model' approach for the entire country. The programmes have necessarily to be location specific and a single package or a model would obviously not suit the entire country and, for that matter, even the whole of a state considering the size of states in India. One practical way would be to make a quick inventory of local resources having growth potential, identification of major constraints in growth based on past experience, mapping of ongoing programmes and projects, and drawing up programmes which may benefit the 'rural poor' and other 'disadvantaged groups' with the ultimate objective of providing full employment. Based on this exercise, a suitable area plan has to be drawn up which may meet the requirements of growth as well as distributive justice in measurable terms. The resources inventory and its analysis may be simultaneously refined using the latest skills and techniques and the action plans modified in the course of implementation. Constant monitoring and concurrent evaluation of various programme components will be a necessary requisite, so that it may be possible to make mid-term corrections. The monitoring should not be limited to mere financial and physical targets in aggregate terms, but it should be indicative of how much additional employment has been generated and how many persons in the BPL (below the poverty line) population have benefited in precise numbers and in terms of additional incomes. The job of evaluation should best be entrusted to an agency other than the implementing organization, so that a detached unbiased view is possible. Monitoring and evaluation should be used as tools for improving the quality of the programmes and the skills of implementers rather than a condemnation of both.

In formulation of relevant R&D projects and their implementation in rural areas, a total system approach involving not only science and technology but also economic, educational, cultural and social aspects should be considered.

In the context of formulation of R&D proposals, some important

areas of work where there are opportunities for science and technology to make contributions are given below. Since these projects are drawn from my own exposure to rural areas, rural people and field agencies, they should be regarded only as illustrative and by no means comprehensive.

The projects have been suggested only in response to the felt needs of the rural population. Several of them also represent new and hitherto unexploited uses of science and technology which may be expected to accelerate rural development and satisfy the minimum needs of the rural population in better and more economic ways than was possible hitherto.

Key result areas:
(1) Water management
(2) Agriculture and forestry
(3) Shelter
(4) Health and hygiene
(5) Village small industries and support to village crafts and artisans

Education is also a very important areas, but it is not discussed here. CSIR laboratories engaged in rural development work should also collaborate with agencies and groups engaged in rural education.

India has an overwhelming majority whose profession is agriculture. The yields in agriculture are very poor, compared to those in many other countries. There are other factors like lack of need-based education which contribute to rural poverty. An essential element in education, whether we call it formal, informal, incidental, etc, should be to aim at development and growth of spirit of cooperation and at meeting the needs and aspirations of the local people.

The above efforts of various governmental agencies are quite laudable. However, mere advice is not enough. In this connection, a full-scale briefing of Panchayats has helped somewhat. Whenever Panchayats have taken interest in the matter, there has been some improvement. The villagers are quite enthused in these programmes and have cooperated whole-heartedly. However, even Panchayats cannot accomplish much. The best means of rural reform and development is indirect, that is, by spreading education. The primary need is to do a good deal of educational propaganda for the necessity of having good and clean houses. But without removing poverty and imparting education the problems of rural people are not likely to be solved.

Project Karimnagar is designed to bring about interaction between science and society, to generate faith in the deliberate use of science and technology for integrated development and to involve people in creative and productive endeavours leading to social justice.

Despite several limitations and weaknesses, the project activity due to its "grass-root planning instead of diffusion of urbanized science" into the rural environment has demonstrated that it is possible to generate self-competence and confidence in the people to utilize their own skills

and resources for gainful productive activity by the use of science and technology as a deliberate tool for growth and modernization. The multiplier effect of the demonstrated technologies is visible. Many other backward areas in the country are keen to try this experiment. Several national and international agencies have offered to assist in the project.

Although a time-frame of two years (1974-76) is too short for the evaluation of results of a project of this nature, it is necessary to make a critical and objective assessment of the progress, so that it should be possible to

— appreciate weaknesses and gains
— overcome any drawbacks
— make changes in approach
— develop new strategies of implementation
— improve organizational set-up and methodology of functioning
— provide additional inputs of science and technology; and
— consider additional sources of funding.

Group activities have been initiated for multidisciplinary review of the project activities, their effects on the rural society, identification and roles of additional instruments of change and provision of a built-in feedback system.

The major weaknesses and gains of the project activity are:

(a) WEAKNESSES

- Being an experiment 'more with society than with science' the execution of the project has been subject to the limitations of social-economic and political environment. It is a new type of experiment without any precedent to take lessons from. In the initial flush of enthusism, the goals were, therefore, set too high. These aspects are now under review.
- Just as the project was taken up for implementation, there was a change in the national economic scene and the public funds for development of utilities suddenly shrank and the revised plans were restricted only to demonstration of new technologies, training programmes, works involving considerably reduced expenditure, and natural resources surveys.
- Although funds earmarked by financial institutions are available, lack of entrepreneurial tradition in the district, and procedural delays in providing credit, have slowed down the process of technology transfer considerably.
- The technological inputs in important fields like agriculture, education and social sciences have been inadequate. Unequal
- inputs in various sectors led to sectoral approach during the execution of the project in contrast to an integrated approach adopted during planning.

- There is an urgent need to set up a cooperative marketing organization controlled and managed by the economically backward people who are being brought into new production activity to counter the existing monopoly; otherwise, the major beneficiary of the development schemes will continue to be the more affluent.
- While detailed surveys have been carried out to assess the potential resources, a deliberate attempt has not been made to evaluate manpower, available skills, and their optimal utilization locally.
- The organization for implementation of the project is too inadequate to cater for the requirements of this multidisciplinary and scattered activity. It requires considerable strengthening to provide leadership and expert advice at site.
- There is hardly any set-up to provide live coordination between various agencies involved in project implementation. Intra-CSIR coordination is also inadequate. It has, therefore, not been possible to provide inputs matching with the work generated

(b) GAINS

- A major gain of the project has been the wide acceptance of science and technology as a deliberate tool for growth and development by the policy makers and the people. The scientists too have recognized their social responsibilities, realized the social factors which contribute towards application of science and technology, and have been exposed to the culture of multidisciplinary teamwork.

  The Karimnagar experiment has catalysed development of several appropriate technologies, e.g. mini rice and maize mills, building materials, biogas plants, rural housing roads, water supply, sanitation technologies, etc.

  The multiplier effect of the dispersed technologies is evident from the follwoing examples:
  - the technologies for rural water supply and road construction have been introduced through the state.
  - the housing designs and construction technology evolved by integration of several technologies have been accepted widely throughout the state.
  - the technique for purification of well water by pot chlorination has self-propagated.
  - the simple technology for the manufacture of building materials like precast stone blocks and other components and of biogas plant domes has been accepted by many even outside the district.

- The schemes for setting up industries under the project are being examined for implementation in other backward areas.
- The project has reached a take-off stage. With the necessary inputs of planning, coordination, technology and funding, it can be successfully carried forward.
- The experiment has generated considerable interest; several national and international bodies have offered assistance.

ROLE OF SCIENCE & TECHNOLOGY IN SOCIO—ECONOMIC DEVELOPMENT

G.S. Rao*

While considering the relationship between science and technology (S&T) and socio-cultural development, we should necessarily bring in economics through which S & T really influences the socio-cultural change. There is no doubt that today it is in the more affluent countries and societies that we find more rapid social and cultural development. There are, of course, traditionalists who will argue that a great poet or painter could be found even in under-developed societies. While one could always find such exceptions, it is by and large in the more affluent societies that higher social and cultural standards are to be found. The role S & T is playing in increasing the economic prosperity of the developed world is now too well-known to need any elaboration. More than any other criterion, the huge investments the developed countries continue to make on S & T bear ample testimony to the role S & T is playing in the economic, social and cultural development of these countries.

Before we consider the impact of S & T on the socio-cultural life of India, we should examine the state of S&T and socio-economic conditions in the recent history of the country.

STATE OF S & T AND ITS IMPACT IN INDIA

Prior to independence, the role of S & T in the national life was almost negligible. We certainly had a Raman winning the Nobel Prize, but these were isolated instances of achievements of a few individuals and science and technology was not a major force as compared to what happened in Europe or America. The situation after independence has changed considerably with the establishment of a large number of R & D laboratories and universities and the recognition that the enlightened leadership of the country gave to S & T.

There has, no doubt, been a tremendous increase in the number of S & T personnel and in the infrastructural facilities for R & D, but what is the impact of this growth on the social and economic progress of the coun-

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try? As stated in the earlier part of this paper, changes in social and cultural conditions are effected by economic progress, which in turn is influenced by S & T. The economic progress that a country makes can be broadly classified under (i) agricultural and (ii) industrial spheres. India has made comparatively more progress in agriculture than in the industrial sector. Aso, the developments in agriculture have come largely from S & T inputs within the country (helped greatly by extension work) and the developments in industry have taken place largely through import of technology. No doubt, Indian S & T has also made some important contributions to industrial development, but major dependence was on imported technology, for various reasons.

The fact that large investments (though small by the standards of developed countries) made in R & D establishments and universities in the country have failed to have much impact on the industrial development of the country is a matter of concern to many people in the country. Many factors contribute to the industrialisation of the country, S & T being only one of them. It is wrong to think that by merely establishing R & D facilities one can bring about industrialisation. While it is not within the scope of this paper to consider other factors like ability to generate large investment finance, availability of raw materials, etc., some of the lacunae in regard to S & T development itself, which contributed to its lesser impact on industrial development, need to be considered. Perhaps two aspects which are important in this regard are : (i) the technology developed in India in most cases is not offered as a turn-key job, which most investors prefer to have, and (ii) the technology offered in most cases is developed on laboratory/bench/pilot plant scale, whereas the investors would prefer to go in for 'proven' technologies (i.e. technologies proven on industrial scale plants). In respect of both these aspects, the technologies offered by foreign firms meet the requirements. One cannot, of course, expect the R & D laboratories to undertake turnkey jobs or to set up demonstration plants (proving plants), because it is beyond their scope. Perhaps organizations like Engineers India Ltd and NRDC could take up these responsibilities.

Another important aspect which has to be looked into, in order to bring Indian S & T into greater play of economic development is to have an integrated plan for indigenous S & T development and import of technology. Lack of coordination between the two activities is largely responsible for continued dependence on imported technology. It is very necessary that the country should plan ahead its future requirements of technology, i.e. identify the areas in which it has to import and the areas where indigenous technology has to be developed over the next 5-10 years. The Indian R & D efforts should be concentrated in fewer areas, so that the technologies developed are most modern, can stand international competition and are capable of finding export market.

Some of the above measures will, no doubt, improve the present

situation. But here we must ask a vital question: to what extent will the modern technologies developed either indigenously or through import, improve the living conditions of the vast majority of the people in India? It is known that modern industrialisation by and large touches mostly urban population and only indirectly the village population. The reason for this is that most of the village people as well as urban people living below the poverty line have no buying power to reap the benefits of modern technology. To improve the lives of these people, it is necessary to adopt some additional measures. There is already plenty of scientific knowledge accumulated in the world. What needs to be done is to sift from this information that which is applicable under village conditions. What are the mechanisms and agencies (governmental and voluntary) already available and which ones have to be newly created to help in the application of scientific and technical knowledge for the betterment of these people? Establishment of small-scale industries. improving the efficiency of cottage industries, training and improving the skills of artisans and various other means have been and are being tried. These certainly have had beneficial effects. But what is the extent of their impact? In the present day context and in the forseeable future, perhaps it is through major improvements in agriculture, that the villagers could increase their income. Like the developed countries, industrialisation takes place around urban centres for obvious reasons and part of the population from the countryside will have to migrate to cities and towns. This is an inevitable process.

Perhaps the best method of helping the people below the poverty line is to educate them in health care, in keeping the surroundings clean, in the use of better gadgets/implements in their trades, and in the application of scientific method in their daily lives. Proper organisational mechanisms have to be created to undertake these tasks. The elements of science and technology which can be easily applied in the villages have to be identified. These should be introduced in an easily understandable form in formal and non-formal education. Community development schemes involving application of science and technology have to be developed. Besides funding by government, large industrial houses should be given incentives to go into these activities in a big way. A massive effort on these lines to educate the village population in the use of science for their uplift and involving them in community development schemes can transform the socio-cultural conditions of these people.

To summarise, this paper tries to emphasise that while considerable progress has been made in India in the setting up of R & D facilities and training of S & T manpower, science and technology is yet to become a major force in the transformation of the Indian society. It is suggested that major technologies developed in India should as far as possible be offered on turn-key basis and after proving them on 'demonstration plants', as is the case with technologies offered by foreign firms. Suitable mechanisms should

be established to fulfil this need. It is also brought out that developements in modern science and technology by and large touch only the urban population and upper strata of society. Therefore, additional ways and means have to be thought of to apply the available scientific and technological knowledge to improve village conditions. One of the methods suggested is to undertake in a big way education of the village population in the application of science and scientific method in their daily lives.

TECHNOLOGICAL DEPENDENCE OR SELF-RELIANCE: AN ANALYSIS OF GOVERNMENT'S POLICY TOWARDS THE DRUG AND PHARMACEUTICAL INDUSTRY IN INDIA*

J MANOHAR RAO†

GOVERNMENT'S POLICY TOWARDS THE DRUG AND PHARAMACEUTICAL INDUSTRY IN INDIA

Since policy decisions with regard to any given sector of the industrial economy are taken within the overall context of the industrial policy, the government's drug policy cannot be examined in isolation. The pharamceutical industry in India, which is mostly dominated by the foreign multinational companies financially and technically, raises some specific questions in regard to equity participation, choice of technology and so on. Hence, a policy for this sector must involve a judicious approach of bringing together of the national industrial and science policies, particularly when the government's objective is one of achieving self-reliance through progressive reduction of foreign control and substantial increase in indigenous efforts both in technology and in production.

DRUG POLICY IN RELATION TO INDUSTRIAL POLICY

A clear and well-defined policy towards the pharmaceutical industry, in comprehensive terms, did not emerge in India until recently, when some of Hathi Committee's recommendations were apparently incorporated into the drug policy. The general guiding principles laid down in the industrial policies and the Drugs and Cosmetic Acts along with the Prince Control orders used to determine the policies towards quality control, levels of

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production, pricing of products and foreign participation in the drug industry.

The Government of India announced its first Industrial Policy Resolution (IPR) in 1948, entailing the maximum utilization of indigenous resources, equitable distribution of goods and services and achievement of higher standard of living as the main objectives. It also recognized the important role of indigenous technology on the one hand and the participation of foreign capital and enterprise on the other, for achieving rapid industrialization in the country[1]. The policy with regard to foreign investments was further explained in the First Five Year Plan, where it was considered desirable that foreign investments "should be channellized into those shperes which were in urgent need of development"[2], and probably the pharmaceutical industry was considered one of those, since a free flow of foreign capital and technology was entertained in this sector. However, the basic framework of Indian policy towards foreign participation in domestic industries was laid down in the Second IPR announced in 1956, though there was no direct reference to the import of technology, nor about the establishment of inplant R&D in indigenous industries[3]. During the Second Five Year Plan period, there was a shift in the pattern of investment and greater emphasis was laid on the growth of the public sector absolutely and relatively to the private sector[4]. Private capital (including foreign), however, was not against increased investment in the public sector, which went largely into areas like infrastructure and machine building involving high risks and long gestation periods and hence not very attractive for private capital to initiate development in[5]. Nevertheless, the pharmaceutical industry was not entirely a state monopoly, according to the IPR of 1956, but was put in Schedule B, in which category both the public and the private (including foreign) enterprises could operate in harmony.

The second IPR states:

> Industries in the second category will be those listed in Schedule B. With a view to accelerating their future development, the State will also have the opportunity to develop in this field, either on its own or with State participation[6].

This leads to a clear suspicion that the development of the public sector in general and the pharmaceutical industry in particular was not aimed specifically at controlling private capital; the outlook was one of co-existence of private and public investments with the intention of promoting the interests of private capital in the long run.

The new Industrial Policy announced by the Janata Government in 1977 also had the avowed objective of creating an industrial base in India mostly with the help of indigenous technology[7]. The stress of the new policy was to develop small-scale and medium-scale sectors by aiding them

through various state and other autonomous financial institutions. Insofar as the pharmaceutical industry is concerned, a new policy with a definite shape was announced a year later in 1978.

PRE-HATHI COMMITTEE DRUG POLICY

While the general guidelines set in the various industrial policies used to govern the overall approach towards the pharmaceutical industry, the specific problems were tackled on a legal rather than the policy plane. The Indian government had adopted from the British, the Drugs and Cosmetics Act of 1940 and amended it at regular intervals. This act governed the manufacture, sale and distribution of various drug products used in the allopathic, Ayurvedic and Unani systems of medicine practised in India. The Drugs and Cosmetics Act of 1940 was first amended in 1955 as Drugs (Amendment) Act followed by further amendments in 1960 and 1962. This Act was replaced by the Drugs and Cosmetics (Amendment) Act of 1964, with subsequent additions in 1972 and 1979[8]. The Act entrusted the government with the power to prevent the emergence of spurious drugs, to maintain quality in production and to provide for the import of drugs wherever necessary. The prices of drugs were, however, controlled from time to time through the promulgation of various statutory orders. The first such order was the Drugs (Display of Prices) Order in 1962 and later the Drugs (Control of Prices) Order in 1963 which were promulgated under the Defence of India Act. However, their impact was minimal and prices continued to rise despite the statutory measures. The drug price index calculated on the basis of the prices of a static group of drugs had risen by 41.9 points by 1970-71, with 1961-62 as the base. A Tariff Commission study was also conducted during 1965-66 to determine the prices of 18 basic drugs and their 69 formulations, which led to the announcement of Drugs (Prices Control) Order in 1970[10]. Strangely, the highest annual increase of 12 points occurred in 1970-71 with the declaration of DPCO. The drug prices were regulated under DPCO 1970 until it was replaced by a new order in March 1979, which was a result of the new drug policy framed in 1978.

The questions concerning joint ventures, technological collaborations and foreign participation in the pharmaceutical industry were more or less governed by the general guidelines set by the Reserve Bank of India and later on by the Foreign Exchange Regulations Act, etc., till recently.

NEW DRUG POLICY

Hathi Committee, which delved into various questions concerning the drugs and pharmaceuticals industry, submitted its voluminous report to the government in April 1975. It took almost three years for the government to come out with a clear and coherent policy in drugs, which apparently incorporated the Hathi Committee recommendations into it. This policy was announced in March 1978[11].

The broad objectives laid down in the new drug policy are as follows:

(i) to develop self-reliance in drug technology;

(ii) to provide a leadership role to the public sector;

(iii) to aim at quick self-sufficiency in the output of drugs with a view to reducing the quantum of imports;

(iv) to foster and encourage the growth of the Indian private sector;

(v) to ensure that drugs are available in abundance;

(vi) to promote research and development by providing special incentives to those firms which are engaged in it; and

(vii) to provide other parameters to control, regulate and rejuvenate this industry as a whole, with particular reference to containing and channellizing the activity of the foreign companies in accord with national objectives and priorities[12].

The objectives listed above were quite comprehensive and well-defined, since they were framed along the lines suggested by Hathi Committee. The first objective is clearly interlinked with the rest and to assess the extent to which the objectives of self-reliance is achieved, a closer examination of at least items (ii), (vi) and (vii) is called for.

MULTINATIONAL (FOREIGN) SECTOR

The foreign multinational companies in the pharmaceuticals industry were to be more or less guided by the Foreign Exchange Regulation Act (FERA) and other regulations, since a very specific policy in regard to this sector cannot be laid down which would be very different from the general industrial policy. The drugs and pharmaceuticals industry is listed in Appendix I of the Industrial Licensing Policy (ILP) of 1973, whereas preferential treatment is given for the allocation of raw materials. Hathi Committee, however, felt that for the purpose of administering sector 29 of FERA guidelines, the foreign companies should be directed to bring down their equity to 40% and further reduce it progressively to 26%. This, however, is without depriving them of other concessions to which they are eligible as a result of being grouped in Appendix I of ILP[13].

The suggested reduction in equity participation does not appear to be an effective instrument for controlling foreign capital. The RBI practice of taking a 40% share in the equity of a firm as a threshold of control is arbitrary enough. It becomes intolerably rigid when a firm has large non-controlling interests in complementary units in an industry; or when a controlling interest in one part of industry is coupled with consultancy interest elsewhere. Effective foreign control could also be exerted when the holder of a majority interest is an industrial giant, very much larger than its majority partner, as has happened time and again in India[14]. Even Hathi Committee's suggestion of progressive reduction of equity to 26% may be ineffective, since it is pointed out that most of the matters that affect

the affairs of a company require three-fourths majority vote; because of this, several foreign investors have found it unnecessary to take more than 26% of the share in the equity, as this gives them an effective veto.

Hathi Committee appears to have considered this point, when it suggested that equity should not be shared in a dispersed form by Indian nationals, but shold be purchased by the public sector undertakings which are connected directly or indirectly with the manufacture of drugs, chemicals or by public financial institutions or by the government itself[15].

The government, however, did not go this far with Hathi Committee, when it incorporated the Committee's recommendations. It directed such foreign companies which are engaged purely in formulation activity to bring down their direct foreign equity to 40%; those engaged in the manufacture of bulk drugs from basic stage which involve high technology and of formulations made out of such drugs are not required to bring down their eqity at all[16]. Such companies were provided with an incentive of a post-tax profit of 14% on 'net worth'[17]. A 14% post-tax profit on net worth would mean about 35% post-tax profit on paid-up capital. Hence, the foreign companies would gain much out of this incentive, their ratio of paid-up capital to reserves being generally of the order of 2:3[18].

Since a number of suggestions came from many quarters and particularly since Hathi Committee recommended that multinationals should not be allowed to manufacture in abundance the less useful nutrients and household tonics, the government took a decision in this regard. It announced in its new policy that any further expansion in capacity for the manufacture of household remedies will not be allowed and for this purpose redefined the term 'drugs and pharmaceuticals' listed under item 14 of Appendix I of ILP. The new definition includes only drug intermediates from the basic stage for the manufacture of high technology bulk drugs and formulations based on them[19]; consequently, it has the effect of making foreign companies which are subject to ILP to confine their production to the bulk drugs only. Hence, an ambiguity arises at this stage, since the FERA regulations appear not to be applicable to those who are engaged in manufacturing the "drugs and pharmaceuticals" in the sense of the new definition.

Herein also lies the question of identifying whether a firm is involved in the manufacture of bulk drugs with or without high technology, which is very difficult to determine. To take a case in point, the Ministry of Petroleum, Chemicals and Fertilizers suggested that almost all the multinational drug companies except two should be treated as high technology units, a suggestion which was rejected by the Reserve Bank of India and the FERA Committee on the ground that this would defeat the basic purpose of amending the definition of "drugs and pharmaceuticals[20]. It should also be noted that so far only eight foreign companies out of the 45 foreign companies listed by the government were identified as engaged only in the pure formulation activity and were directed to reduce their non-resident interest to 40%[21].

INDIAN (PRIVATE) SECTOR

The Indian private sector is comparatively smaller than the foreign multinational sector. Hathi Committee recommended that a more liberal policy should be adopted to encourage the Indian companies to make their contribution to the production of bulk drugs and formulations. It even recommended that such items as are manufactured by the Indian companies need not be imported. The new drug policy apparently considered these aspects and announced that the small scale sector would be a prohibited area for foreign firms. Hathi Committee had recommended that the foreign companies should provide 50% of their total bulk drug production to non-associated Indian formulators[22]. But the government's decision permitting it to be given to any non-associated formulator would invariably result in one foreign company giving the material to another foreign company, nullifying the intended effect of the provision.

The government, while declaring its intention to favour the Indian private sector in the drug industry in the matter of capacity regularisation, in fact formulated policy which favoured only the multinationals. The criterion of regularisation of production in excess of licensed capacity was: "the highest production actually achieved in any year during the three year period ending 31 March 1977" was to be treated as regular capacity[23]. In fact, Hathi Committee felt that any regularisation of excess capacities should not be allowed, particularly in the foreign companies. But the government's decision to consider up to the year 1977 would amount to legalisation of the unauthorised capacities of most of the multinationals, since the bulk of the illegal capacity built up prior to 1977 belonged to the multinationals.

PUBLIC SECTOR

The case for a strong public sector gained momentum since the second IPR, as it was believed that state ownership in industry would offset the undue profits to the private companies, particularly to the multinationals. Hathi Committee's recommendations had reaffirmed this faith in the context of the drugs and pharmaceuticals industry and suggested that the public sector be given a leadership role.

The new policy, in order to achieve the country's objective of self-reliance and self-sufficiency in the production of drugs and pharmaceuticals, assigned a big role to the public sector. The public sector was also given a major role in the production of capital and technology-intensive bulk drugs which were needed in large quantities and where large scale production was economical. The new policy also laid the responsibility for the distribution of life-saving drugs with the public sector and suggested that all the public sector units should have greater coordination among themselves to meet the demands of the public health services[24].

The Hathi Committee had identified 117 essential drugs and reserved 34 drugs exclusively for production by the public sector. The new policy,

however, reserved 25 drugs for the public sector and 23 for the Indian private sector; about 66 were open for all the sectors[25]. Most of the antibiotics and life-saving drugs appear to have been allotted to the public sector, with the expectation that it should bring about some positive achievements.

The public sector's target, in the new policy, to produce bulk drugs worth Rs.300 crores per year by 1983-84 appears to be an ambitious task, when compared with the present bulk drug production of around Rs.50 crores by the public sector[26], and demands gigantic and well organized efforts to achieve the target. Hathi Committee had suggested that the public sector should also take up the production of some specific synthetic drugs which were being imported and whose production was essential. The new policy, however, seems not to have considered this seriously.

The new policy, while attempting to put the public sector in a leadership role in bulk drug production, had no provision to ensure that the public sector does not become a servicing sector for the private industry. The formulation industry of the private sector, dominated by the multinationals which derive their main source of profits through formulation activity, depends on the bulk drugs produced by the state owned companies. Hence, it would have been a better proposition for the public sector to start its own formulation activity instead of selling the drugs in bulk form to the private formulators.

TECHNOLOGY AND R AND D POLICY

This area calls for a closer coordination between the national science policy and the sectoral technology policy with a view to promoting in-plant R and D in the industrial units. A national body like the National Committee on Science and Technology (NCST) should govern the overall programme of indigenous research efforts in various sectors with close collaboration of national laboratories. Hathi Committee's recommendations are adopted in the new policy in this regard, which announced that with the involvement of the National Chemical Laboratory, the Central Drug Research Institute and the Regional Research Laboratories, the development of indigenous technology would be taken up.

In order to reduce dependence on import of technology in general and in the pharmaceutical industry in particular, the new policy laid down that the public sector units and the national laboratories would be equipped with pilot plants, so that they have a strong design and engineering component in their R and D structure[27].

Since the foreign companies show little interest in tropical drugs research, the new policy accorded highest priority to centrally directed research aimed at discovery of new drugs for treatment of tropical diseases, viz. antimalarials, anthelmintics and so on[28]. The public sector is supposed to set an example in this respect by investing 5% of its net turnover on R and D activity.

With regard to foreign drug companies, the government decided that the right to determine the import of technology for new bulk drugs by such companies should be vested in the hands of the government and directed the foreign companies even to undertake transfer of technology to the public sector units where national interests justify[29]. This, however, may not cut much ice, as the past record suggests. When Hindustan Antibiotics Limited (HAL) entered into an agreement with Merck of USA for the manufacture of streptomycin, it was found that Merck was getting higher 'titre yield' than HAL (titre refers to the quantity of solution required to convert a compound into another form). Later, the US company was found using a strain very different from that supplied to HAL and the reason given was that Merck had obtained that strain from Glaxo and HAL was not entitled to its use[30]. But the fact is that it was Merck's responsibility, according to the terms of the agreement, to see that the entire yield in HAL was as that of the original manufacturer. A pertinent question can also be raised: if Merck itself was on the lookout for another source for improved strains, then how could it undertake to provide improved technology to HAL? Hence, it appears that the multinationals are capable of even defying the terms of agreement and resorting to misleading and dubious practices.

Another policy directive suggests that the foreign companies whose turnover in drugs is in excess of Rs. 5 crores per annum should have R and D facilities within the country on which capital investment should be at least 20% of their net block and that they should additionally spend at least 4% of their sales turnover as recurring expenditure on R and D facilities[31].

PRICING POLICY

The pricing policy of drugs, as explained earlier, took the form of various control orders since the 1960s, but these could not arrest the price rise effectively. Hathi Committee, which went into the question of pricing of drugs in detail, had recommended that the mark-up[32] for the essential drugs should be cut drastically, while more liberal mark-up should be allowed for drugs which are not essential. Hathi Committee had also suggested the identification of a 'leader product' and the fixation of a 'leader price' to such products in different groups[33].

The new policy, which claims to have based itslef on an exhaustive examination of these recommendations, announced that all the bulk drugs which are used in the production of price-controlled formulations would be subject to price control. The important drug formulations currently marketed are grouped into four categories. The pricing of formulations in categories I and II is worked out on the basis of product groups of equivalent therapeutic value and makes use of the leader product and leader price concepts. In category III formulations, though separate pricing for each product is adopted, application of the leader price technique is not totally ruled out. The mark-ups have been 40%, 55% and 100% respectively for categories I, II and

III. Category IV formulations are not subject to price control and hence there is no control over this mark-up.

There is no convincing rationale behind the categorisation of formulations, since both life-saving and non-essential drugs are there in the first three categories. The manufacturers who suffer due to a relatively lower mark-up in categories I and II are amply compensated by marketing products in category III. Another important point to be noted here is that almost all the items included in the first two categories are well known and very little promotional expenditure is required for their sale. Category IV formulations are exempted from price control, but the price worked out by the manufacturer has to be stated on the label. An average consumer may not know which formulations are controlled and which are not. Hence, the consumer does not have any choice, except paying the price stated on the lebel, since it is more than likely that he would proceed on the assumption that it is a controlled price which appears on the label. The Government, perhaps, has the intention of subjecting the formulations to competitive forces of the market by removing the price controls. However, this argument does not hold good, since almost all the formulations are sold under brand names and hence only the product competition exists, edging out price competitive forces of the market by removing the price controls. However, this argument does not hold good, since almost all the formulations are sold under brand names and hence only the product competition exists, edging out price competition; this implicitly amounts to a cartel type operation.

While the general pricing policy in the pharmaceutical industry decides the level of multinational domination through market sales, a specific policy is required for the public sector, since it is a decisive factor in holding the price line in the market. Unless the public sector is in a position to offer drugs at competitive prices, it is very difficult to reduce the domination of multinationals particularly in an industry like the pharmaceuticals.

Hathi Committee had recommended that the public sector should make drugs available to the masses at cheaper prices. Some studies had suggested that the pricing policy of the public sector has a rationalising and stabilizing effect on prices in the drugs and pharmaceuticals industry[9]. However, the evidence provided in Table 1 suggests quite a different picture. A group of seven important products have been selected on the basis of price discrepancies between the public sector and the private (including foreign) sector companies. It is found that the prices of two antibiotics, viz. benzyl penicillin and fortified procaine benzyl penicillin, produced by both HAL and IDPL, were higher than those charged by Glaxo by 54% and 50% respectively. Chloramphenicol, another important drug produced by IDPL, is priced 32% higher than the same drug produced by May and Baker. IDPL's price of phthalyl sulphathiazole is exorbitantly high and is 83% more than that of Dey's Chemicals, an Indian firm. Hence, it appears that

the public sector pricing policy, instead of having a rationalizing effect[34] rather helped the MNC's to continue their domination.

Public sector drugs are mainly distributed through government concerns and state agencies and organisations throughout the country. For obvious reasons most of the drugs are not backed by promotional techniques. Hence, it is difficult for them to compete with the branded products, except through competitive prices. It also becomes imperative for the public sector to have a more realistic pricing policy in the light of the declared objectives of providing drugs in plenty at cheaper prices, and loosening the multinationals' stranglehold on the price system.

ABOLITION OF BRAND NAMES

The generic versus brand names controversy has been a long drawn out one in the pharmaceutical industry ever since a case for generic names of drug products arose. The government had partially implemented Hathi Committee suggestions by abolishing the brand names of five drugs, viz. Analgin, Aspirin, Chloropromazine, Ferrous sulphate, Piperazine and its salts, such as adipate, citrate and phosphate. The detractors of generic names have always advanced the argument that Pakistan had resiled from its earlier decision to abolish brand names on an ostensible plea that this resulted in a glut of spurious drugs in the market. However, there are so many examples of successful operation of marketing generic drugs even in advanced countries, such as USA and Canada, that this argument has little validity.

CENTRALIZED BUYING

A number of policy measures have been suggested by various supra-national organisations, such as OECD, UNIDO, UNCTAD and UNITAR, to reduce the degree of influence of multinationals. One such policy measure which is considered to be significant is centralized buying on a national scale. The case for centralized buying[35] became popular with the experiment by the State Pharmaceutical Corporation (SPC) in Sri Lanka, which is believed to have successfully reduced MNC domination.

A similar measure is adopted in India by the Chemicals and Pharmaceutical Corporation (CPC) of India Limited, which is a subsidiary of the State Trading Corporation. It is pointed out that after canalising the drugs through CPC, there were substantial savings in the buying of indomethacin, trimethoprim, gentamycin, doxycycline and metronidazole in 1977. Table 2 shows the savings achieved after CPC had bought the drugs through worldwide tenders. These drugs were further canalized to the individual manufacturers through CPC itself. However, this had not resulted in any lowering of the retail prices. This might be because of high mark-ups by CPC and due to the operations of other middlemen.

Table 1

Price comparisons of some formulations produced by public and private sectors

Sl. No.	Name of the product	Name of the mfg. unit	Pack size	Retail price allowed Rs.
1	2	3	4	5
1.	Benzyl Penicillin inj. Penicillin G. Sodium	IDPL	5 lac' vial	1.05
		Alembic	-do-	0.87
		Glaxo	-do-	0.70
		HAL	-do-	1.08
		IDPL	10 lac' vial	1.55
		Alembic	-do-	1.42
		Glaxo	-do-	1.42
		HAL	-do-	1.58
2.	Fortified Procaine Benzyl Penicillin inj.	IDPL	4 lac' vial	0.88
		Alembic	-do-	0.77
		Pfizer	-do-	0.77
		HAL	-do-	0.93
		IDPL	20 lac' vial	3.38
		Alembic	-do-	2.46
		Pfizer	-do-	2.66
		HAL	-do-	2.75
3.	Streptomycin Sulphate inj.1 gm	IDPL	1 vial	1.22
		Sarabhai	-do-	1.18
		Pfizer	-do-	1.13
		HAL	-do-	1.23
4.	Chloramphenicol caps. 250 mg	IDPL	100 bottle	40.88
		Alembic	109 bot	32.10
		May & Baker	100 bot.	30.15
		Smith Stani-street	100 strip	37.67
5.	Thromycin tablets, Erythromycin Estolate	IDPL	10s strip	14.80
		Themis	10s strip	13.11
		Anglo French	10s strip	15.52

1	2	3	4	5
6.	INH tablets 100 mg	IDPL	1000 tin	33.05
		Pfizer	-do-	30.41
		Sarabhai	-do-	25.99
7.	Phthalyl Sulphathia	IDPL	1000s tin	133.78
		May & Baker	-do-	96.20
		Dey's	-do-	72.99

Source: Compiled from answer to USQ No. 1188, by Surendra Bikram, Lok Sabha Debates, August 1979.

Table 2

Saving Due to Canalization of Drugs in India, 1978

Sl. No.	Name of the drug	Quantity of imports 1977-78 (tonnes)	CIF price before canalization (Rs./kg)	CIF price after canalization (Rs./kg)	Amount saved (Rs./kg)
1.	Indomethacin	1	4320.00	364.83	3955.17
2.	Trimethoprim	2	2060.00	561.34	1498.66
3.	Gentamycin	0.1	70180.00	35378.00	34802.00
4.	Doxycycline	1	2037.00	1608.00	428.12
5.	Metronidazole	20	250.00	152.00	98.00

Source: Answer to Unstarred Question No. 1821, by Motibhai R. Choudhury, Lok Sabha Debates, November 1979.

There is no doubt that the establishment of a nationalised wholesale monopoly might result in substantial savings, but this does not always necessarily lead to lower retail prices. Hence, a still more comprehensive policy measure is called for in this regard.

SUMMARY AND CONCLUSION

A coherent drug policy was not in existence till the announcement of the new drug policy. The general guidelines were derived mainly from the Industrial Policy Resolution of 1948 and the Industrial Policy Resolution of 1956. During the Second Five Year Plan period, greater emphasis was laid on the public sector in order to prevent the emergence of monopolies and the concentration of production in a few private industries. The pre-Hathi Committee drug policy was more in the form of legal statutes, price controls rather than in the shape of a specific policy approach towards achieving self-reliance in production and technology. The questions concerning foreign participation and transfer of technology were determined by the guidelines set by RBI and FERA in the drug industry. Despite the importance given to the public sector and various controls aimed at containing the dominance of multinationals, little was achieved. Hathi Committee went into different aspects of the drug industry and came out with valuable recommendations in its report in 1975. The Janata Government, which came to power in 1977, announced the new drug policy in 1978, apparently after the inclusion of some major recommendations of Hathi Committee.

The new drug policy was definitely a positive outcome in the sense that it contained specific, long-term prescriptions for the pharmaceutical industry. It laid down some important guiding principles, though ambiguous, to reduce foreign domination in the drug industry by assigning a big role to the public sector, providing incentives for the Indian private sector and encouraging indigenous R and D activity. However, a number of loopholes exist in the new policy which may ultimately defeat its objectives. The provisions regarding the manufacture of drugs involving high technology, for example, would be thoroughly used by the big private capital (MRTP companies) and the foreign capital (MNC's) for manipulating the RBI guidelines and FERA regulations in regard to equity participation and the setting up of illegal capacities, to the detriment of the declared objectives. The pricing policy in the new drug policy is most arbitrary and gives ample scope to the Indian private companies as well as the foreign companies to take enough advantage out of it. The approach of the public sector towards prices of drugs is in no way better, and indirectly helps the multinationals in maintaining their lead in the market. Abolition of brand names of five important drugs is one positive and bold step of the present policy. However, this may not have much impact, since the brand named drug products rule the roost in the entire drug market and the share of the drugs devoid of brand names is very little. Another step which should have had a positive effect is the buying of drugs through global shopping around; however, this, where it has been adopted, has led to lower import costs without any reduction of the retail prices.

REFERENCES

1. *Industrial Policy Resolution, Government of India, New Delhi, 6 April 1949, para 8-10.*

2. *First Five Year Plan, Government of India, New Delhi, 1952. p.142.*

3. *Industrial Policy Resolution, Government of India, 30 April 1956.*

4. *Jagdish Bhagwati & Padma Desai: India: Planning for Industrialisation, Oxford University Press, London, 1970, 86-87.*

5. *The authors of the Bombay Plan, however, expressed the idea that private capital could take over the more profitable public investments at a later date and also hoped to buy up some of the enterprises which were to be created in the public sector. See, The Bombay Plan, New Book Company, 1944.*

6. *Industrial Policy Resolution, Government of India, New Delhi, 30 April 1956, para 10-14.*

7. *Industrial Policy Resolution, Government of India, New Delhi, 23 December 1977.*

8. *The Drugs and Cosmetics Act and Rules, Government of India, Department of Health, New Delhi, 1979.*

9. *P.S. Agarwal, P.K. Ramachandran & B.V. Rangarao: "Anomalies in Drug Price and Quality Control," EPW, Vol.7, Nos. 46 and 47, 1972, 2285-92.*

10. *V.L. Mote and H.N. Pathak: "Drug Price Control' An Evaluation", EPW, Vol.7, July 15, 1972, 1469-79.*

11. *The present study does not take into account the political change and its impact on the economy due to the change in the government in 1977.*

12. *Government Decisions on Report of the Hathi Committee, Economic Intelligence Service. Centre for Monitoring Indian Economy, Bombay, April 1978. (hereinafter referred to as New Drug Policy or NDP).*

13. *Report of the Committee on the Drugs and Pharmaceuticals Industry, Government of India, New Delhi, 1975, Chap V, para 21 (Hereinafter referred to as Hathi Committee Report or HCR).*

14. *Michael Kidron: Foreign Investments in India, Oxford, London, 1965, 188, 287.*

15. *Hathi Committee Report, Chapter V, paras 22-23.*

16. *NDP, paras 15, 16.2 and 44.*

17. *'Net worth' means the 'share capital' (equity) of a company plus 'free reserves', if any, and a free reserve is created by appropriation of profits. For detailed definition in the context of the drug and pharmaceutical industry in India, See Drugs (Price control) Order 1979, Government of India, New Delhi, 1979.*

18. *Economic Times, New Delhi, 26 August 1977.*

19. *The new definition is as follows: "(a) Drug intermediates from basic stage for production of high technology bulk drugs; and (b) high technology bulk drugs from basic stage and formulations based thereon with on overall ratio of bulk drugs consumption (from own manufacture) to formulation from all sources of 1:5." NDP. para 13 and 14.*

20. *The Ministry had argued that all the bulk drugs could be treated as high technology items, and hence all the units manufacturing such items make the 'core sector'. See, IDMA Bulletin, Indian Drug Manufacturers Association, Bombay, Vol. XI, No.8, February 29, 1980, 88-89.*

21. *Answer to Unstarred Question No. 1817, Lok Sabha Debates, December 1978.*

22. *HCR, Ch. V, para 22.*

23. *Ibid., para 27.3.*

24. *NDP, para 12.*

25. *NDP, Annexure I.*

26. *For a detailed analysis on public sector in drug industry in India,see, J. Manohar Rao, "New Drug Policy and the Prospects of Self-Reliance: A Study of the Drug and Pharmaceutical Industry in India (1974-79)", Ch. III, M. Phil. Dissertation, submitted at CSSP, SSS, Jawaharlal Nehru University, New Delhi, 1981.*

27. *NDP, para 86.*

28. *NDP, para 81.*

29. *NDP, para 40; the statements in paras 86,81 and 40 of the new policy are based on the recommendations contained in HCR, Ch. V, Para 13(t) and Ch. VII, paras 22, 36, 37 and 39.*

30. *See for some more details, C.V. Gopalakrishnan, "What Role Multinationals?" The Hindu, Madras, 23 July 1977.*

31. *A close examination of R and D expenditures by various multinationals shows that some of the large companies too do not spend much on R and D. See, J. Manohar Rao, "A Note on R&D in Private Pharmaceutical Firms in India" Paper presented at the All India Seminar on "The Drug Industry and the Indian People," November 7-8, 1981, New Delhi.*

32. *'Mark Up' includes distribution cost, outward freight, promotional expenses, manufacturer's margin and the trade commission. See DPCO 1979, para 11.*

33. *The criterion of identifying a 'leader product' is on the basis of 60% of the sales of a product in a therapeutic group, accounted between different manufacturers. Maximum prices may be prescribed on that basis and units may fix prices anywhere within that ceiling; see, HRC, Ch. VIII, paras 36 and 37.*

34. *Agarwal and others have based their analysis on the retail price differentials of 19 drugs and found that multinational selling prices were 100 to 300 per cent higher than the public sector's. However, this should not lead to any generalisation, as suggested above.*

35. *Sanjaya Lall & Senaka Bible, "The Political Economy of Controlling Transnationals: The Pharmaceutical Industry in Sri Lanka (1972-76);" EPW, August 1977; also, World Development, July 1977.*

MEDICAL PROFESSION, MEDICAL TECHNOLOGY AND HEALTH CARE FOR ALL

VIJAY KOCHAR *

ORIENTATION OF ORTHODOX MEDICAL CULTURE (The Blue Medicine)

The paper proposes to discuss the technological orientations of the medical profession as a culture group and identifies its linkages with elite, business agencies and other vested interests. The professional power groups perpetuate the creed of ever-increasing specialization, mechanization, medicalization and bureaucratization in the name of high quality medical care. The cult of drugs has been thoroughly commercialized under the sponsorship of medical profession. The pharmaceutical and medical engineering firms have joined hands with medical profession in perpetuating the self-serving dogma of high quality care under the banner of professional autonomy.

All this has led to increasing costs of medical care, alienation of the consumers, dehumanization of patients, mystification of medical procedures, decline of general practitioners, neglect of preventive medicine, and denial of health care to the masses. Bureaucrats have joined hands with the professionals in strengthening autonomy and in reducing the accountability of medical profession. It is strange irony that autonomy and control of medical profession have increased without appropriate mechanisms for regulation of professional practices, prevention of malpractices, consumer protection, and overall social and legal accountability. So far as the common man is concerned, not even the administrative checks or peer control mechanisms exist to protect him against even the gross irregularities and malpractices. These stories have become a legion. Intricate evasive mechanisms exist to evade responsibility and accountability such as mutiplicity of personnel sharing medical care, control or denial of record and information, unwillingness to judge, control or sanction the erring colleagues, uncertainty of diagnosis, prognosis and therapy, use of patients as "subjects", obtaining consent or self-discharge declarations from the patients in unfair manner, total lack of responsibility for dispensation of prescription, etc.

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Professional training and socialization centering around complex, exotic, technological, sophisticated and rare medical problems lead to the neglect of common and simple health problems of the masses, devaluation of general practice, degradation of preventive and promotive skills, and neglect of health service goal of the health organizations. The medical colleges, teaching hospitals, research institutes and large private hospitals are increasingly becoming the prestigious repositories of latest medical technological hardware, irrespective of the quality of care in general. Even preventive and social medicine is not free from this technological obsession. Search for new vaccines, new tests, new mass screening methods, or even new communication technology is viewed with greater respect than simple, sound and effective procedures designed to be delivered through health workers. "Community Medicine" is deemed to be more appropriate than "Community Health". Gereral practice is being redefined as a speciality. Industrial health, environmental medicine, social paediatrics and health administration are also regarded as specialities.

LIMITATIONS OF HALF-WAY MEDICAL TECHNOLOGIES

The paradox of modern medical technology is clearly evident in the developed countries, particularly U.S.A. Progress of medical technology is mistaken for progress of health care or improvement in the health of people. Many studies have shown inverse relationship between progress of technology and progress of the health of the people, that is, health has declined in U.S.A., with the progress of medical technology. Since progress of health service is identified with the progress of medical technology, the same pattern of negative relationship has been demonstrated between health of the people and health service indicators such as health expenditure, quantum of health services, density of health organizations, density of medical practitioners and specialists, etc. The greater the density of medical institutions, the poorer is found to be the health of the people. Similarly, no direct relationship exists between the discovery and diffusion of medical technology and the reduction of health problems. Conversely, historical as well as contemporary studies in different countries have demonstrated that reduction in the prevalence of some major diseases, reduction in infant morality, reduction in general morbidity rates, increase in life expectancy, etc., are unrelated to the progress of medical services. The case of small-pox eradication is potent. The essential medical technology for small-pox eradication was available more than 80 years ago. Except perhaps for multi-shot vaccination gun, no real breakthrough in medical technology was involved in small-pox eradication. The success was largely due to organizational techniques and campaign planning or support by the international agencies.

Three effects of technological progress in medical field in U.S.A. are clearly recognized. One is the fact of run-away costs of medical care. Medical

care for common man is a tremendous burden, despite support through insurance systems. The second is the presence of preventable multiple health problems amidst profusion of medical resources such as S.T.D.s in epidemic proportion. Third is the fact of health problems created by the medical technology itself, referred to by Illich as iatrogenesis.

The impact of medical technology is most glaring in the realm of artificial life saving and life supporting devices, labour saving or unique automative devices for diagnostic functions, surgical and operation-theatre aids and the plethora of patent drugs. Organ transplants, artificial organs, microsurgery, test tube babies and artificial prolongation or sustenance of life are the most spectacular feats. Use of some of these technologies has, however, evoked a strong bio-ethical debate. In response to such doubts, the medical profession itself is deeply divided. Some are advocating a moratorium on the use of such techniques.

It is generally not recognized that even in developed countries, most of the above-mentioned technological feats benefit a very small proportion of population. These apply to a very small fraction of ailments suffered by a small fraction of population. In India, the advanced bio-medical technologies mentioned above are available only to much smaller number of patients due to limitations of trained experts, limited availability or applicability of such technologies, and due to prohibitive costs. Even for those who avail of them and achieve some success in prolonging life (or generally delaying death) these technologies have very little, if any, potential to contribute towards better quality of life. In western countries , modern medical technology has created a pool of degenerative survivors. We will come to this question later.

Another fact to keep in mind is that the costly modern medical technology is necessarily located in large hospitals of large cities only, thereby restricting the distribution of and access to these resources. No large hospital-based service can form the basis of primary health care. Serious inequities exist in the distribution of medical technologies. Studies also suggest that physicians tend to over-use and misuse technological procedures in hospitals, further limiting the availability to others. Some hospitals and insurance agencies in U.S.A. have been forced to tighten regulations for the use of costly technologies or to devise some rationing system.

New medical technologies have triggered important changes in hospital organization as well as in the organization of medical care. One of these changes is in the relationship of doctors to hospitals (or the technology-based hospitals). More and more doctors must find linkages to these hospitals and research centres in order to make use of technological facilities available there. Various mechanisms have consequently emerged. Group practice is one such solution for intermediate technologies. The hospital managers on the other hand have been forced to restrict such access to technology through bureaucratic rules and procedures. The private practitioners find these inconvenient.

Another result has been fragmentation of medical care, whereby different professionals, specialists and technologists cater to specific but limited needs of the patients. This has further deteriorated doctor-patient relationship. Impersonal elements predominate in machine-minding procedures of care. Patients hardly get to know what is going on and what the procedure implies. Technology thus enhances the powerlessness of patients in organizational milieu in which their rights are infringed with impunity. Technology-based interactions are important factors in dehumanization of patients and care.

Studies also show that costly technology does not usually enhance the quality of care, patient satisfaction or the quality of post-treatment rehabilitation. A study counted 80,000 coronary bypass surgeries in U.S.A. in a single year (1976), each costing more than $12,000. The study comments "the surgery benefits only a minority of patients, and even then its effects are limited to the relief of chest pain and increased tolerance.....There is no evidence that (it) prevents myocardial infarction or affects long term survival rates (Milliman 1977, "The unkindest cut"). Various authors have also noted widespread diffusion of new medical technologies before the benefits, risks and limitations have even been properly assessed. The patients become guinea-pigs. These costly technological procedures are "pushed" by the biomedical engineering firms in collusion with insurance agencies and hospital authorities even before the organization is prepared to make proper and full use. Consequently, these are often installed and operated well below the cost-effective levels recommended. For example, in the above case, 85% of the coronary bypass surgeries in U.S.A. were conducted much below the recommended cost-effective level of 200 cases per year.

ORIENTATION OF RADICAL MEDICAL CULTURE (The Red Medicine)

Having discussed some major inherent limitations of traditional half-way medical technology for medical care, I will shift to the scenario of primary health care which represents a radical movement in the medical profession.

Primary health care philosophy recognizes health as a fundamental right and a social goal. Primary health care is to be made universally accessible "bringing health care as close as possible to where people live and work", "through their full participation in the spirit of self-reliance and self-determination". Primary health care is designed to be essential comprehensive health care through practical, scientifically sound, and socially acceptable methods, making fullest use of local resources, including the participation of suitably trained community health workers. Primary health care is supposed to be the central function and main focus of national health system with different tiers designed to compensate, support and strengthen the community-based health care activities. Primary health care calls for balanced distribution of health resources, delivery of health care at the

doorstep, effective and efficient implementation, special attention to major health problems of problem groups, use of appropriate technology, and emphasis on development as an important means of attaining health improvement.

NATURE OF DEFINITIVE RADICAL TECHNOLOGY FOR PRIMARY HEALTH CARE

First of all it must be recognized that primary health care does not reject medical technology, but calls for development of appropriate technology for essential comprehensive health care — technology that is acceptable to and usable by the people, health workers and paramedicals. This technology is addressed to most common health needs and health problems of the masses. This technology is designed for prevention and control of diseases, cure of common ailments and promotion of health. Thus, primary health care accords highest priority to simple and more efficient preventive and curative technology that can be acquired, learnt, propagated and used by community health workers and paramedical workers with least risk. Next in importance are the technologies that general physicians in charge can use for efficient and effective implementation and management of primary health care through community workers and paramedicals These are social technologies for managerial, educational, administrative, planning, evaluative, community organization and programme promotion. Also important are the technologies that can be placed with or shared by the general physicians in management of serious, but less complicated common health problems, save those that must be referred to higher centres of medical technology or to ambulatory care teams from such centres.

Simplification and transfer of medical technology to paramedicals, auxiliary workers, and community health workers is a fundamental requisite of primary health care. These technologies can pertain to the whole range of tasks and activities involved in comprehensive primary health care from sanitation to nutrition, M.C.H., C.D.C., and medical care. The tasks may range from promotion of cases, education, registration, delivery of service, follow-up visits, and support to other visiting health teams. Preventive technology takes precedence over curative technology.

The appropriate technology for primary health care is meant to optimize the use of local resources, and adaptation to the local conditions. This technology should be acceptable to and affordable by all those who need it.

ORTHODOX CRITICISM OF RADICAL MEDICINE

The concern of professionals for quality of care and for maintenance of desirable bio-medical standards of accuracy and quality is an integral value orien-

tation of orthodox medical culture. Delegation of health care functions and medical technology to health workers or to people invariably creates shock waves among the medical professionals. Medical culture does not inculcate the value of self-reliance among the "patients"; it inculcates the value of dependence, control and unqualified compliance. Since the doctor knows the best and only he can understand the hidden risks and intricacies involved in health care decisions, any delegation of health care functions beyond the realm of his direct and immediate supervision is deemed to be fraught with immense danger. Self-care is taboo in medical culture. Delegation of health care functions to health workers is seen as encouragement of quackery, involving grave risks. It is regarded as advocacy of third rate care for the poor masses. Use of simple procedures and restricted access to medical technology at the primary health centres is seen as misuse and degradation of the calibre and skills of trained professionals.

Orthodox medical culture puts lower value on preventive medicine reflected in a great variety of ways. During medical training, preventive medicine receives a lower allocation of time, resources and faculty positions. The choicest students and best faculty go to medicine and surgery. Preventive medicine is lowest in the pecking order of medical occupational hierarchy. Preventive medicine is considered less scientific, less technical, less challenging, vague, commonplace and commonsense level knowledge. Medical students and medical faculty regard preventive medicine training as "picnic", "excursion", "waste of time". In government, all kinds of professionals get into preventive medicine jobs from pathology to pharmacology.

Primary health care shares these orientations of orthodox medical culture due to its affinity with preventive medicine and community health. This is in good part due to lack of good research and scientific information in this field.

THE QUESTION OF QUALITY

The above description gives an impression that primary health care technology being simple is unsophisticated and of poor quality. This is not correct.

Firstly, creating a simple technology may require a great deal of sophistication and expertise in developing and standardizing it. In fact, the state of art for primary health care technology is at a very low ebb and far from satisfactory. This is primarily because primary health care technology is taken too casually. The available primary health care technology is grossly inadequate and sub-standard, leading to frequent failure of the programme activities. The problem is not because the medical technology is simple, but because the professionals believe it is simple and develop it simplistically in slip-shod manner. Secondly, the so-called simple technology may sometimes incorporate the most advanced technology. Examples are

available of the use of electronic technology for primary health care. It may even be linked to space technology. Such technologies have been deployed in Mexico, Western U.S.A., Alaska, Guatemala, U.S.S.R. and Indonesia. Thirdly, simple technology does not mean poor quality care. Technology should be judged poor if it fails to manage the given task efficiently and effectively. Quality of care should be judged by the results of technology, not by the cost, size or sophistication of the technology itself. Simple technology may often be the most cost-effective, usually the most appropriate for the given tasks, and the most appropriate in the environment in which it is to be used. This is difficult to comprehend by those professionals who are accustomed to take for granted the use of available, costly technology even for simple conditions or procedures.

Studies have shown that 70-80% of ailments for which people seek care are manageable by simple common remedies. About 15% of ailments are of somewhat serious nature, requiring careful attention, but are still manageable by the paramedicals and health assistants if detected and taken care of early. Fixed and standardized course of action can be packaged in manuals for the guidance of paramedicals in order to eliminate avoidable risks. Use of simple technology for simple tasks does not mean derogation of quality of care. Simple technology that can be made availabe to everyone cannot be compared with complex and costly technology that can never be made available to everyone. About 5 to 8% of cases are found to require personal attention of a general physician who can diagnose and manage these problems through basic medical technology. Here again, the quality of care by physician through basic technology cannot be compared with the quality of care at a super-speciality hospital. Only 1 to 2% cases require more sophisticated medical attention of specialists and use of special technology placed at bigger hospitals. The super-specialist oriented frontline super-technology we referred to above is really applicable and used for a very small fragment of cases, who can afford it and demand it. Even in England, it is estimated, less than 1% of cases seen by a general practitioner may potentially need specialized medical care and technology. Thus, each technology is functionally meaningful (efficient) at a certain level of use within a given environment. Each technology requires some basic infrastructure that goes with it. The more complex the technology, the more elaborate is the necessary infrastructure. Technology has different relevance and applicability at different developmental levels which can provide such infrastructure. The use of locally produced weaning foods in place of costly commercial baby foods, use of breast feeding in place of bottle feeding, use of bangle and growth chart in place of sophisticated biochemical tests for malnutrition, use of salt-sugar oral rehydration in place of chemotherapy, use of soap in place of antibiotic lotions for burns, use of domestic aseptic delivery in place of obstretric theatre — all these may seem poor quality options to the professionals who are used to manage these conditions within hospital/

clinic setting in cities. In rural domiciliary settings, the above choices are more practical, more effective, and hence of better quality. Mobile, portable or ambulatory devices, devices that can help health workers in taking correct and timely decisions, devices through which complex tasks can be performed by less trained workers, devices that can communicate with and instruct the health workers in the field, devices that can teach health workers and people what action to take in given exigencies, etc., are within the realm of primary health care technology.

THE QUESTION OF QUACKERY

There are different levels of medical technology matching with different levels of health problems and the health care tasks associated with these problems. The above argument against delegation of health care responsibility to health workers or even to people ignores the basic fact that overwhelming proportion of tasks associated with prevention of diseases and care of simple common ailments does not require personal attention and involvement of medical professionals. In fact, such demands on their time and services will amount to inadequate use of their skills and training. The high risk cases or serious-chronic ailments requiring careful examination, diagnosis and treatment should be the ones to engage their time and attention. These are the skills for which physicians are trained at phenominally high cost. It is perhaps uneconomic and inefficient to use their skills for day to day preventive and promotive follow up or for simple common ailments which are self-limiting or which can be easily managed by people themselves or by suitably trained health workers. A simple ailment can perhaps be made to appear unduly complicated by recourse to unnecessarily elaborate and complex clinical procedures, by over-medication, or by unwarranted use of medical technology. These are unfortunately the kind of technological rituals by which medical professionals mystify their performance. Medicalization of the mundane and mystification of simple is the trap which professionals build around themselves.

There could be little disagreement on the scientific principle that remedial action should be commensurate with the risk involved. The technology should match the task involved. When there is a mismatch between the remedial action taken and the known nature of the problem itself, then science is replaced by quackery. Quackery is the art of performing tasks totally unrelated to one's knowledge or the solution of the problem and yet giving a false impression that it is so. Use of simple tasks directly and scientifically related to the appropriate solution of the health problems is not quackery. On the other hand, inappropriate performance of health care tasks, use of inappropriate procedures and techniques irrelevant to (or deleterious to) care of given health problem, or use of latest medical tech-

niques and new remedies totally unrelated to the management of a given health problem cannot make a practice scientific only because the tasks are performed by trained professionals. These too, perhaps constitute a form of professional quackery. Conversely, a correctly performed and useful procedure or task does not become third rate only because it is performed by a less trained person or by a lay person. If the technology employed is appropriate and if the manner of its use is correct, then it is both scientific and useful. The costly drugs are not necessarily always the best drugs. The specialized medical procedures are not necessarily always the most relevant ones. The costly super-specialist physicians are not necessarily the most qualified for all kinds of health care tasks.

If the primary health care task for a given child is of providing appropriate recommended nutrition, of providing watchful continuous care as directed, of ensuring that recommended precautions are meticulously followed, of maintaining good personal and food-water hygiene, then perhaps in village setting, the mother of the child is the best person to be entrusted with this task. The other alternatives of hospitalized care or of personalized care by a trained nurse are unavailable, impractical and unaffordable for most of the cases. To those who can avail of it and afford it these options become practical. Level of care cannot be separated from the level of development of the family, the community and the region. Who can object to placing a clinic, a nurse and a doctor in every village (as in U.S.A., may be), but is that a practical and a scientific solution? Should rural masses be deprived of even minimal care (albeit of so-called of "poor" quality), until the remote future in 21st century when the so-called good quality care by the physicians can be made available to them?

TECHNOLOGY AND SOCIAL ENVIRONMENT

Technology is structurally-functionally linked to culture and social organization. There is a set of appropriate perceptions, appropriate behaviour patterns, appropriate social environment, appropriate facilities, appropriate skills, and appropriate procedures associated with each technology. The culture of the medical profession and the culture of urban elite has good fit with modern medical technology. However, the traditional folk cultures and village social organization do not provide the pattern of behaviour, perception, social relationships and facilities which the modern medical technology assumes. There is inherent contradiction which results in "medico-cultural lag" and "medico-cultural conflicts". These gaps and conflicts presumably increase with the enhancement of medical technology. Even in western countries, some medical technology is efficient at life saving and life prolongation, but the social organization is incapable of providing the kind of social support and care needed by these beneficiaries of life saving technologies (e.g. renal dialysis and renal transplant, coronary bypass,

artificial cardiac support devices, etc.). Even their hospitals are incapable of providing the needed follow-up for these patients.

The technology and standards of care (or quality) cannot be separated from the social environment in which these are to be applied or used. Practicality of technological application is represented by the concept of appropriateness. What is appropriate technology in one social environment may not be so in another social environment. This to a great extent depends upon the level of development. Appropriate technology is better technology by the logic of practicality and social acceptability even if it entails relatively poorer standards. Apropos is the example of American tourists in England who religiously refuse to accept water there because of assumed poorer "standards". By those standards most water sources in India will have to be declared unfit for human consumption. Obviously, it is impractical to apply here those standards of quality. Therefore, the technology which aims at such high standards of quality will be meaningless and redundant.

Acceptability is another drag on the quality of medical technology. Unless people accept and use a technology in large numbers, its value for a destined target function will remain low, irrespective of the highest quality or standard it may represent. On the other hand, a relatively inferior technology immediately acceptable and usable by the people will make greater impact and therefore will be more appropriate. The future technology will then aim at improving or suitably replacing the existing less efficient technology with an increasingly more efficient technology.

Medical technology thus has a necessary link with the indigenous practices and techniques which the former is designed to replace or modify. A knowledge of this link can be of immense help in designing a more acceptable appropriate technology.

Technological and social changes generally occur in small incremental steps, except the changes triggered by catastrophic events or by social movements. Life threatening events, for example, may initiate a drastic technological change. In the normal course, improvements in the existing technology or introduction of new technology befitting the life style, daily routine and their needs is more likely to be accepted and quickly diffused, provided, of course, that the new technology does not seriously alter some important/valuable social situations.

I do not intend to dwell here on the technique of developing appropriate technology, but to indicate that primary health care technology for rural masses must relate to their life situations. The primary health care technology should be designed for the use of health workers and the people in given life situations and should be preferably based upon the use of local resources.

PLACE OF ORTHODOX MEDICAL TECHNOLOGY IN PRIMARY HEALTH CARE

There is nothing intrinsically wrong with the definitive and purposeful modern medical technology. It has been noted that modern curative technology creates conflict between the interests of a person and the interests of society (Hiatt 1976). It also creates strong moral conflicts in its application and use. Conversely, it may be argued that technology is neutral or amoral — neither good nor bad. It is the manner and context in which modern technology is used by hospitals and medical professionals and the manner in which health system ignores other more vital functions of primary health care for all which creates conflict. In west, this conflict is created by the vested interests of technology producers, and technology promoters, the insurance agencies, the hospital owners, hospital administrators, the rich and influential elite clients, the high-income medical specialists, etc., and the support they all manipulate from government, power bodies, professional bodies, and other public organizations. The same technology can acquire greater relevance if put at its proper place in the total context of primary health care, if its use is geared to public good, and if it is not allowed to overshadow other more important priorities of the hospitals, the professionals and the health system. In the process, perhaps, the medical technology will lose its glamour and glitter. The specialized professionals who use it will lose their prestige. The place this technology has in medical education and research will naturally be lowered in comparison to primary care technology. The prolongation of the life of terminal patients will naturally be of low priority in the scheme of primary health care where prevention and care is basically designed to create a better life for the masses by attending to their most common health needs, by eliminating major risks to their survival, and by restoring optimal well-being of the largest number. The higher medical technology at larger hospitals may still have a place of relevance within primary health care, except for a shift in emphasis and selections of technology that can cater to the much wider population, or to more important health problems of the population at large. In large public hospitals, the emphasis will have to be shifted from isoteric ailments, rich clients and purposeless prolongations of terminal life to complicated presentations of common ailments, less common but difficult conditions referred from a large primary care hinterland, saving the life of able bodied persons, and restoration of capacity to function normally and meaningfully (rehabilitative medicine).

BIBLIOGRAPHY

Bachrach, Leona L. Deinstitutionalization: An Analytical Review and Sociological Perspective. U.S. National Institute of Mental Health (Series D.No.4), Washington, D.C.: N.I.M.H., 1976.

Barber, Bernard, Lally, J. and Makarushka, J.M.: Research on Human Subjects: Problems of Social Control in Medical Experimentation, New York: Russell Sage Foundation, 1973.

Behney, Clyde J.: Studies of the Implications of New Medical Technologies: The State of the Activity. Staff paper for the National Council of Health Planning and Development, Health Resources Administration. Washington, D.C.: H.E.W., August 1976.

Bellin, Lowell E.: "Politics, Not Technology, Is the problem in Health Care Quality Control." Man and Machine 1 (Winter 1976): 124-125.

Carlson, Rick J.: The End of Medicine, New York: John Wiley 1975.

Crane, Diana. The Sanctity of Social Life : Physicians' Treatment of Critically Ill Patients. New York: Russell Sage Foundation, 1975.

Donabedian, Avedis. Benefits in Medical Care Programs. Cambridge: Harvard University Press, 1976.

Donabedian, A.: 1980. The Definition of Quality and Approaches to its Assessment. M.I.

Durbin, Paul T.: ed. Guide to the Culture of Science, Technology & Medicine. Free Press, New York, 1980.

Fox, Renee C. and Swazey, J.P.: The Courage to Fail: A Social View of Organ Transplants and Dialysis. Chicago: University of Chicago Press, 1974.

Fox, R.: 1979. Advanced Medical Technology - Social and Ethical Implications. In R. Fox Essays in Medical Sociology. John Wiley. pp. 413-462.

Fox, R. : 1979. Organ Transplantation: Socio-cultural Aspects. In R. Fox, Essays in Medical Sociology, John Wiley, pp. 115-121.

Frazier, Howard S., and Hiatt, Howard H.: "Evaluation of Medical Practices". Science 200 (26 May 1978): 875-878.

Fuchs, Victor R.: Who Shall Live? Health, Economics, and Social Choice. New York: Basic Books, 1974.

Gallagher, Eugene B., ed. The Doctor–Patient Relationship in the Changing Health Scene. H.E.W. – N.I.H. 78–183. Washington, D.C. : H.E.W., 1976.

Gray, Bradford H.: Human Subjects in Medical Experimentation. New York: John Wiley, 1975.

Hiatt, Howard H. : "Too Much Medical Technology". Wall Street Journal 24 June 1976, p.16.

Illich, Ivan. Medical Nemesis: The Expropriation of Health, New York: Pantheon, 1976.

Jequier, N. : Appropriate Technology: A Challenge of the Second Generation. In Tyrrell D.A.J. et al., 1980. Infra.

Knaus, William A.: Schroeder, Steven; and Davis, David O. "Impact of New Technology: The CT Scanner." Medical Care 15 July 1977: 533-542.

Krause, Elliott A. Power and Illness: The Political Sociology of Health and Medical Care. New York; Elsevier, 1977.

Levin, A. (ed) : Regulating Health Care : The Struggle for Control, Academy of Political Science, New York. 1980 pp. 148-157.

Lewis, Charles E, Fein, Rashi, and Mechanic, David : A Right to Health: The Problem of Access to Primary Medical Care, New York: John Wiley, 1976.

Luke, R.D. and R.E. Modron, 1982: Professionalism, Accountability and Peer Review. Health Service Research, 17 (2): 113-123.

Mechanic, David. "Ideology, Medical Technology, and Health Care Organization in Modern Nations" American Journal of Public Health, 65 (March 1975) : 241-247.

Mechanic, David. ed.: The Growth of Bureaucratic Medicine, New York: John Wiley, 1976.

Mechanic, D. Future Issues in Health Care. Free Press, New York, 1979.

Millman, Marcia. The Unkindest Cut. New York: William Morrow, 1977.

Russell, Louise B. : "The Diffusion of New Hospital Technologies in the U.S." International Journal of Health Services 6 (1976): 557-580.

Rustein, D.D. : The Coming Revolution in Medicine. M.I.T. Press, 1967.

Simmons, Roberta G., Klein, Susan D. and Simmons, R. : The Gift of Life: The Social and Psychological Impact of Organ Transplantation. New York: John Wiley, 1977.

Thomas, Lewis. The Influence of Science and Technology on Medicine: A Forecast, Ciba Foundation Symposium. New York: American Elsevier, 1975.

Tyrrell, D.A.J. et al.: More Technologies for Rural Health, Royal Society, London, 1980.

ECOLOGY AND DEVELOPMENT : CASE STUDY OF ARUNACHAL PRADESH

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I

In 1978, I was working along with one of my colleagues for evaluating the effect of rural electrification programmes in the North East on behalf of the Rural Electrification Corporation. It is in connection with this study that we came across considerable material on Arunachal which began to interest me in the question: "What is the effect of the rapid development of a region on its delicately balanced ecology?"

In my earlier studies in the Bhil region and some acquaintance with the Gond region I had come across records which referred to the thick jungles in the Dud and the Gondwana areas and yet these areas are today in the throes of an ecological disaster. The rainfall is becoming more erratic and droughts more frequent. Since the nemesis approaches only slowly, the mortal men do not often recognize its approach. The unfortunate part of it all is that it is avoidable, provided appropriate steps are taken to protect the forests and extend the vegetation in the region.

The study of the relationship between development and ecology is of particular interest in Arunachal, because, unlike the tribal areas in Peninsular India, the strategy of development adopted in Arunachal was, in some respects, different and better informed. There was, for example, some sensitivity shown towards the dangers inherent in allowing free access to Caste Hindu and other commercial or land hungry elements within the region. The large scale exploitation of the autoethenes in Peninsular India — Bhils, Gonds, Mundas, Santhals; the merciless process of land alienation and often their conversion to low-caste bonded labourers by immigrant Caste Hindus, etc., were too welll known to be repeated. The ethnic problem of Assam emerging largely from uncontrolled immigration was also a living reminder to avoid that easier path of development. That there has been a much happier response to the changed strategy of development from the natives of Arunachal is recorded by one of our prolific anthropologists, C Von Furer-Haimendorf. "The developments in Arunachal Pradesh are undoubtedly one of the success stories of present-day India, and one wonders why the as-

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tounding progress of the tribesmen of this region is being covered with a veil of secrecy, while the far less creditable situation in the tribal areas of Peninsular India can be observed without any need for official permission." (Haimendorf : 80. p.9.10)

While affirming the strides made by the people of Arunachal towards a modern state within India, our study attempts to highlight the dangers inherent in "development" itself, particularly if it is informed by the possible dangers arising from over-exploitation of forests. Our study is approaching the policy framework in the context of a wider set of contextual relations and, therefore, suggests that there will be, on the horizon, another problem — far more dangerous for the succeeding generations — if the present generation fails to take note of it now, viz., the large scale decimation of forests and the consequent hurt to the ecology of the region. It is with this concern that we wish to make a tentative statement highlighting the following sets of relations:

- Ecology and economic variations in the region.
- Economy and alternative energy use patterns in the region.
- Urbanisation with its related processes as affecting the traditional energy use patterns.
- Policy alternative frames concentrating on immediate gains vs future dangers to ecology.

In a relatively short paper all facets of the relations mentioned above cannot be presented. Therefore, we have been very selective in our description. An attempt is made to bring in only that much data which will illustrate the essential points being made.

II

In the north eastern part of India, spread over 31,440 sq.miles — astride the majestic Himalayan range — is the many splendoured state of Arunachal. To its north is Tibet, now an integral part of China, to the west, the State of Bhutan. Much of the southern boundary is shared with Assam, except in the extreme south-east, where a spur of Arakan range has been included in the State of Arunachal. Here, Arunachal shares its border with Nagaland. The south-eastern border, generally, touches Burma.

In the years before Independence (1947), Arunachal was part of the unadministered frontier betwen the notional Mc Mahon Line and the foothills region where Miri and Bodo tribals practise a kind of farming similar to that of tribal peasantry.

The North Eastern Frontier region, though scantily adiminstered, was in fact not socially totally isolated even then. The Budhist communities living in the western, northern and north-eastern parts of the region had

ancient traditions of trade and commerce both with the more primitive "forest dwellers" and the people of the Brahmaputra plains. The earliest anthropological studies are dated in the 40's of which C. Furer Von Haimendorf's study of the Apatnis and their neighbours is now a classic anthropological work. Soon after the creation of the North-East Frontier Agency, Verrier Eluru was appointed the Adviser of Tribal Affairs to the Agency. It is in this capacity that he wrote his famous book 'The Philosophy of NEFA.'

It would not be accurate, in the anthropological sense, to describe all the ethnic groups of Arunachal as tribal communities, since a number of them are segments of the various branches of the Budhist civilization, with their own nuclei of "high culture". Again, these communities are internally differentiated in terms of class and role specialization. Its "products of culture" — jewellery, bell metal wares, woolen textiles and iron instruments — had found their way into the Brahmaputra plains since times immemorial. Again, the "tribals" of the terrai areas whose main sustenance is cultivation of terraces and lower valleys of the tributaries of the Brahmaputra, are, in terms of economy and culture, so similar to the other peasant communities that their definition as "tribes" is only a "juridical" device. This is, of course, not to deny that the legal protection which the classification "Scheduled Tribes" affords them, ought to be given to them on account of the general backwardness of the region. The economy and culture of the region, though differentiated, yet has a certain "brittleness" which is associated with segmentary tribal social systems. Thus, because of the legal difinitions, all the autochthous groups are scheduled as tribal communities and are given certain constitutional rights by which nontribals are not allowed to buy lands or set up business enterprises without explicit permission of the administration. In fact, the whole of the North-East, barring Assam and Meghalaya, is covered by an "inner-line permit system", which effectively controls population movement into the region. Thus, while the tribal communities of the region have freedom of movement all over India and can compete for employment or enterprise and take part in the democratic forums of the country, the tribal communities of the region are guarded against the more aggressive and better placed trading and migrant farming communities from the rest of India.

The policy devised under the leadership of Jawahar Lal Nehru, effectively takes care of the danger of the nontribal communities exploiting the tribals and through large scale migration becoming a majority in these areas. At the same time, effective extension of administration and the initiation of developmental activities in the region has started the process of integration of the tribal groups in the plural society of India.

Prior to independence, the British had not interfered in the traditional system of adjustment between different communities and the systems of internal government practised traditionally by all communities. After inde-

pendence, many of the democratic forums, including elections to Auchal Panchayats at the local level and state assembly at the (U.J.) state level, have been introduced, which have made it possible for the emergence of new forms of leadership. By now, there are a number of local politicians who are experienced in matters of state and articulation of local interests.

III

North Eastern Frontier Agency was created in 1951. The region was divided into four districts. In 1972, the Agency was made into a Union Territory with its own assembly and a council of ministers to administer various local development projects, and coordinate various aspects of civil administration. After the establishment of the Union Territory status, the administration has been further extended. There are now five districts and altogether fourteen administrative centres for development and civil administration.

After 1961 war with China, the presence of the military adminstration has increased vastly. The Border Roads Organization has constructed enough roads connecting the administrative centres with the national highways. The Union Territory administration further constructed roads connecting all important villages with the administrative centres.

IV

Since the material and cultural life of simple societies is rooted in the ecological environment and is largely shaped by the resources of flora and fauna, a brief description of the topography, climate and flora and fauna is called for.

Arunachal is full of valleys, ridges and mountains, often rising up to 7000 metres. The vast topography is deeply dissected by rivers and rivulets which ultimately flow into Brahmaputra. In this kind of topography, climatic conditions can change dramatically within short distances. There are contrasts in temperature and rainfall between sheltered valleys, foothills and mountain tops. Yearly rainfall varies from 90 to 380 cm.

Generally, monsoons begin in March and last till the end of September. In spite of the wide range, there is enough rainfall over all the region for wet cultivation and rice crops can be sustained even in low rainfall areas with the help of stream irrigation, provided the land is otherwise suitable for permanent cultivation.

Pines and other related tall trees do not grow very well and naturally beyond 10,000 ft. above sea level, but up to that level, all varieties of trees ranging from the tropical, and sub-tropical to temperate climate trees are found. Between 10,000 and 22,000 ft. above sea level, grasses and shrubs grow and it is occasionally possible to grow barley and wheat even up to 12,000 ft. a.s.l.

A major proportion of the 31.4 thousand sq. miles area of Arunachal consists of sub-tropical and temperate forest (approximately 10.5 thousand sq.miles). About the same proportion, i.e. one-third of the total area is arid, stoney and/or snow-bound. Much of the forest is unsurveyed and claimed by various tribal villages; reserved forests cover around 400 sq.kilometres area.

V

The whole of the region may be roughly divided into three broad ecological sets of niches with a variety of intermediate sub-regions. In the western and north-western districts, particularly Kameng district bordering Bhutan in the west and Tibet in the north, the higher reaches of the range are populated by the Monpas, a group of Tibeto-Mongolian people whose main sustenance comes from a combination of terraced agriculture on ridges and high land valleys and animal husbandry, particularly breeding and grazing mithuns, yaks, sheep and horses in the higher slopes during the summers. During summer and rains, when grass in lush even over the higher ridges, the families move up the hills into their summer homes. These are spread out over different hillocks. Since agricultural work connected with ploughing, seeding and weeding goes on throughout the summer, depending on the specific labour requirement for the job, members of the family may travel down daily or occasionally to conduct their agricultural activities on the potato, rice, barley and wheat patches. By and large, men tend to stay back in the hill or the forest looking after the grazing of sheep or cattle. Winters are spent in the village houses at the bottom of the hill, located on ridges close to the streams. People live in sturdy double storeyed stonehouses with wooden plank floors. The doors and the doorframes are often carved. During winter nights, the pigs and cattle imported from the plains are kept on the ground floor, while family members live on the upper floor. The heat of the animals keeps the householders warm. Monpas and other related tribes are industrious people with mastery over many different crafts. Being a frontier community with sale marginal agriculture, Monpas depend on trade and craft such as carving and carpentry. Bell metal work such as temple bells, plates, shields, elaborate lamp stands, woollen textiles, carpets, stone and silver jewellery and a thousand other things are manufactured by households specializing in one or a number of crafts.

The second ecological niche consists of relatively lower, central and eastern ridges of the range. This consists of flora varying from tropical to sub-tropical, thickly overlaying the whole hill ridges and the higher valleys. This area is characterized by relatively heavy rainfall duing the monsoons followed by dry spells from November to April. The major mode of production for the people in this ecological niche is shifting cultivation on the

hill slopes. By and large, the shifting cultivators grow a hill variety of rice and supplement their nutrition with root crops, barries and meat of the hunted animals and domestic mithun, pigs and dogs.

The shifting cultivators live in huts built on stilts and clustered on top of a hill, more or less centrally located within their territory. Some individual householders may have patches of permanently cultivated land where vegetables and fruit trees of local variety may be grown. Shifting cultivation requires collective effort and the hill slopes coming under this form of agriculture belong to the village and its dominant clan.

The third ecological niche consists of the highland valleys and the foothills. Here, the climate is generally mild and the land fertile, because of the continual supply of fertile earth coming down from the hills with the seasonal streams during monsoons. There is also a fairly good supply of water throughout the year. People living in this niche, therefore, grow irrigated rice, vegetables and fruit trees. They have domesticated mithuns and other cattle, which are rarely used as draught animals and are kept mainly to eat along with domesticated fowl, pigs and dogs.

VI

There is a certain correspondence between the cultures and economies of the peoples of the three ecological niches. The northern and western rocky and arid region is populated by people of Tibeto-Mongolian origin. Most of these communites are Budhists and have had centuries of close relationship with the Budhist civilization centres such as Labsa. As communities ecologically intermediate between the Budhist civilizational centres and the tribal hinterland many amongst them developed the skills to trade and commerce. It is largely through Sherdukpens and Monpas that trading linkage has been maintained between Tibet on the one hand and the Ahoms of the Brahmaputra valley on the other. Similarly, Tangsas and Khamtis were instrumental in maintaining trade links between Ahom country and Iravady valley cultivation. An interesting characteristic of these communities is that because of niggardly natural endowments of their "niche", they were forced to rely upon a variety of modes of production, of which cattle herding was usually the main source of livelihood, but not among all the communities. What characterizes these communities is their industry and trading abilities. These communities were thus able to maintain a fairly high level of material culture and occupational diversification.

The inhabitants of the second set of ecological niches, viz., "shifting cultivators" of the sub-tropical forest consist of tribal groups such as Mishmis, Nishis, Noctes and Wanchus. They are by and large self-sufficient groups, relatively isolated, reticent and withdrawn. It would be incorrect to say that they do not engage in any trade. They have some needs for the products of the culture, viz., iron arrow tips, daos, some cloth and kerosene.

These things they exchange for forest produce such as musk, febrifuge, surplus pigs and fowls. These tribal groups have their own religions and religious mythologies more or less free from Hindu and Budhist influences. The material cultures of these groups are extremely simple. Cloth is used only to cover the genitals; pottery, black smithy and many of the other arts are absent.

The third set of ecological niches refers to the people of the valleys. These people engage in permanent cultivation based either on irrigation of rice fields or terraced cultivation of wheat and barley strengthened by regular use of animal compost and draught bullocks. Boro, Kachari and Apa Tani's can be included in these groups. These people have fairly high levels of material and non-material cultures and are far more integrated with the plains culture. Some of the richer members among them are traders. These tribal groups are either integrated into the Hindu fold (Kacharis Boros) or have their own tribal gods (Apa Tanis). Like their non-tribal brethern, they exchange some of the surplus rice, vegetables, arecanuts and forest produce against clothes, shoes, kerosene, spices, textiles, torches, bicycles, transistors, etc.

VII

The three sets of ecological "niches" described above are ideal types. The reality of nature and of huamn social constructs, in fact, is not as clearly defined. Let us take the example of Sherdukpen group which we had included in the first category, but when looked at in their cultural detail, they combine some elements of the other two types as well.

Sherdukpen are a sub-tribe of Monpas. According to the 1961 census, they number approximately 1,200 souls, living largely in two villages — Rupa and Shergaon. These villages are located in south-western Kameng District. Their immediate neighbours to the west and south are Sherchopkas, a sub-group within the Monpa tribal group. Sherdukpen's permanent fields are located in the valley of Duplako about 5000 ft. above sea level. The valley is watered by many perennial streams, but the soil depth is shallow and the fields are covered with stones. In addition to wheat, barely, maize and millets, Sherdukpen grow barely, mustard, potato, sweet potato and various other vegetables.

Besides permanent cultivation in the valley, Sherdukpen also do shifting cultivation on the hill slopes. Although the hill sides appear loaded with shrubs and trees, conifers, yews, oaks, birches, magnolias, rhododendrons etc., the slopes are not too suitable for slash and burn cultivation. The hills are usually too steep and rainfall is comparatively light, ranging from 30 to 32 inches a year. The shifting cultivation cycle, therefore, has to be considerably lengthy to allow for sufficient rejuvenation of the forest soil. Ob-

viously, agriculture alone is not a sufficient source of sustenance for Sherdukpen, and they have to supplement their incomes by trade, carrying Tibetan salt to Khowas and Hurros tribal settlements, Chinese silks, wool cloth, and semi-precious stones to the major bazars of Upper Assam. A remarkable feature of Sherdukpen life is the annual migration to a place called Doimara. At the beginning of the cold weather, the entire tribe, with the exception of a few caretakers and very old people, moves south to a settlement, a few miles from the plains.

VIII

Let us describe Nocte community as an example of the group adjusted in the second type of ecological "niche". We choose this group again to emphasize the point that natural resource endowments combined with geographical locale often produce certain characteristics in a group which one does not associate with the general type.

Nocte are the major tribal group inhabiting Tirap district which touches North Assam in the south and Burma and Nagaland in the east and south east. Nocte belong to the Chin group of tribals; their fellow brethern are known as Konyaks across the borders. Nocte live by and large by shifting cultivation. They need iron implements — daos, axes, spears, arrow heads and cotton yarn. However, unlike other "shifting cultivators", they produce enough salt from the salt springs found in their region. Some of this salt they barter with other neighbouring tribals and also with the border communities.

Nocte are a patrilineal society stratified into princely and commoner clans. Princely clans are united by cross-cutting affinal relations from different villages but commoner clans usually marry within the same village. Each chief takes a principal wife from any other chief clan, but he also takes a number of secondary wives from the commoner clans within his village. Thus, a chief has a sizeable number of people of his own lineage within the village as well as affinal allies among other powerful families in the neighbouring villages.

IX

We will take up a brief description of the Apa Tani community as an example of the third type of ecological "niche", viz., the valley dwellers.

The Apa Tani valley is set in a landscape typical of most of the middle ranges of the Eastern Himalayas. Densely wooded mountains, which rise from narrow valleys, often as low as 1,500 ft. to heights between 8,000 and 9,000 ft., form range upon range of mountains unbroken by level grounds. (Haimendorf : 80; p.11)

Apa Tani valley, however, is one exception. Located in the heartland

of Arunachal at an average height of 3,000 to 4,000 ft. above sea level, it is populated by Tibeto-Mongolian people. They are ancient migrants to the valley and had remained somewhat isolated from both Budhist and Hindu influences right until 1944, when NEFA established a base at one corner of the valley and gave it the name of Ziro. Until the late sixties, government intervention in the affairs of the valley people was marginal, but since then Haimendorf noticed very rapid changes in the life of the people.

Apa Tanis engage in wet rice cultivation on terraced lands. The water management system developed by Apa Tanis is a marvel of industry and ingenuity of a people who must have developed these techniques entirely through endogenous efforts. Water tapping begins before the hill streams enter the valley. The stream waters are dammed with stones and logs at various points and diverted through channels to the terraces, which are both cut off the hill slopes and constructed with stones and filled with mud from lower terraces. Channels on the other end of the terraces drain surplus water into a stream which may again be trapped to provide water for the terrace below. Practically the whole valley right up to the bottom fields is filled with terraces. The terraces on the upper reaches are, of course, narrower and those in the bottom broaden out to become decent sized fields.

The work in the rice fields is done almost entirely through human labour. Women use iron hoes to cut the hillsides and men fill the mud on to the wooden trays and drag them to the parts of fields that need filling and levelling. The houses of the Apa Tanis are located on higher grounds within the valley. Parts of the higher grounds are used for kitched gardens and tree groves. Because of the marshy conditions during the rains, the houses have to be built on stilts.

The village habitat consists of a number of such houses located close to one another. Usually, a mud road raised above the level of the fields links the habitat with the metalled roads, which, in turn, link the villages with the district headquarters. In the centre of each such locality there is usually a plaza, a "square" surrounded by residential houses and the village lapang or clubhouse.

Apa Tanis are also a patrilineal society. They do not have extensive marital linkages outside the valley. In fact, the hills surounding the valley are occupied by the shifting cultivators — the Nishis and the Mishmis.

X

At this stage it would be appropriate to discuss the nature of inter-dependence between the three types of "Ecological niches". First let us briefly mention some of the common features. All the major ethnic groups, except the recent migrants, are of Mongolian stock. Most of them traditionally lived under conditions of primitive adjustment to the geographical and social environs constituted by their tribal neighbours.

The Budhist communities on the borders between Arunachal, Tibet, Bhutan and Burma have tended to survive even though placed in most rigorous natural surroundings by adopting a variety of technologies and strategies to earn their livelihood. They have been simultaneously cattle herders, shifting cultivators, terraced cultivators and above all expert traders as well as artisans — jewellery making, metal work, cloth making, have provided them goods to exchange for wheat, rice and other goods. By and large, their relations with their neighbours have been peaceful.

The valley dwellers, both Apa Tanis and Adis of the Terai, have come into conflict with their tribal neighbours — the shifting cultivators — who appeared as marauders, off and on and demanded a share in the affluence of the wet rice cultivators. However, even these neighbours, over a period of time, learnt to live together by the valley dwellers paying and the tribals receiving tributes. The cooperation between the valley dwellers and hill tribals is demonstrated by a number of institutions. Apa Tanis give the Nishi and Miri tribals their cattle to graze on the basis of sharing the offspring. Monpas migrate lock stock and barrel during summers to the plains and live with their hosts in the plains. Thus, there existed a loose-jointed non-nucleated regional social system with no fixed boundaries, but constituted of people who by and large living in their own fastnesses did keep in touch with their neighbours largely for limited economic exchange.

XI

There was a certain balance in the technologies used by these communities and the natural resources available to them. The budhists did not over-exploit their arid stoney soils, since their populations were kept within control by various institutions, including a system of polygamy and polygyny, which kept the population of women low. In every family men chose to stay away from home due to long trading expeditions. Again, some members of the family joined the Budhist monastries and were thus a factor for reduced rates of population increase. The shifting cultivation was also practised in moderation and through a longer cycle to allow for the rejuvenation of the burnt forest patches. The population of the valley's wet land cultivators was also more or less stable because of high rates of mortality.

XII

At this stage, let us have a look at the energy technologies used by the tribal groups. Basically, the traditional economy is motivated by three sources of energy, viz., the human muscle power, wood from the forest and in some cases animal power, which is available to some Budhist communities as well as some Adi peasant communities in the Himalayan foothills part of Arunachal. Some of the Budhist communities also use water wheels to turn the ritual drums.

Shifting cultivation is a system based upon fertilisation of the soil by ashes of the bamboos, trees and shrubs on large patches of sloping hillsides. Logs of wood are burnt and the ashes spread over the field. A village usually does not cut and burn more than a small number of patches. The ashes provide potash, which also helps to fix some nitrogen in the soil. One field may be used for one to three years. Barley or rice or even vegetable crops may be grown by different families during different seasons. As already indicated, the villagers shift to other hill slopes and leave the burnt patches to recuperate. Complete recuperation takes around 40 years, but the tribals usually return to the same patch within 20-25 years. The slopes which come under slash and burn (or Jhumming) are usually without ancient pine or oak trees. Shorter duration varieties of trees and bamboos which usually constitute the second storey plant species are the usual flora that survive man's intervention. This, of course, does not mean that bigger trees have disappeared altogether. In fact, hill slopes steeper beyond 45° are not convenient for Jhumming; they are, therefore, invariably left untouched.

Human and animal excreta is the chief source of fertilising the fields of the valley dwellers. The valleys that get flooded by mountain waters do not suffer from lack of natural nutrients. These are rechanged to the valley soils by the humus flowing down with the streams. However, whenever some additional nutrients are required, these are supplied by the method of piling dried shrubs and grass and burning these to get ash as the fertilising medium.

Wood is partically the only source of cooking and heating energy.

Certain types of firewood is brunt mainly to provide light in many tribal homes. Some of the wet rice cultivators make use of bullocks for tilling their fields. Sherdukpen, for example, use bullocks or cows for this purpose. The yoke used to harness them is conspicuous by its breadth. In their permanent cultivation fields, they practise rotation — wheat or barley alternately following maize or millet. The plots left fallow in the third year are manured by leaving the pigs and cattle in the fields to graze on plant roots and grass.

Apa Tanis keep cattle, both the hill variety mithun and the plains variety. These are, however, kept only for their meat. Traditionally, bullocks were not used to till the fields. Like most other Mongolian groups, Apa Tanis do not take milk. Cattle are kept essentially for beef. Now-a-days milk is taken in tea, particularly at the teashops at Ziro.

XIII

Let us now look at the changes occurring in the economic life of the region and the manner in which these changes are affecting the ecology and society of the many ethnic groups.

The rapidity with which the region has been incorporated in the national life is demonstrated by the fact that whereas there was hardly

any motorable road before 1945, a number of motor roads were constructed after the creation of NEFA, particularly linking the Brahmaputra valley with the important Indo-Tibetan passes. During the 60's and 70's besides the introduction of a number of national highways for defence purposes, the district headquarters are linked with various village communities as well. Again, places which were earlier merely local markets with not more than half a dozen shops have now become thriving commercial centres, where tribals can bring their surplus agricultural and forest produce and exchange this with the imported items, as well as barter or buy things from one another. Great acceleration of the market economy can, of course, be traced to the fact that Indian army and the civil administration have introduced a large number of well paid staff with ready cash. Construction of office buildings, roads, and since the early 70's various kinds of industrial activity have also introduced money in the region, which reaches the ordinary tribal folk through the markets, the contractors and the tribal employees working in government offices or on building and roads construction.

We must remember that unlike some of the tribal regions of Peninsular India, entry of businessmen from outside the state has been restricted; therefore, a great number of commercial establishments are managed by the tribals themselves.

Land under shifting cultivation had usually been owned collectively in the villages of the shifting cultivators and labour on the communal land was contributed by the village families on more or less equalitarian basis. Some private family plots owned by families had to be cultivated by them continuously for three years. Usually, these were near the house site which was the exclusive usufruct of specific families. On this land, the families grow vegetables, gourds, potatoes, etc., more or less year after year. As the requirement of extra cash has burgeoned, the individual family units have started terracing some of the unclaimed land in the lower reaches where they grow fruit or arecanut trees.

The agricultural communities like the Sherdukpen, Apa Tanis and Miris had since long owned wet lands privately. For Apa Tanis and Sherdukpen, even the hill slopes, if cultivated, belonged to the families that initiated the cultivation. The grazing lands in the forests were, however, no one's property and hence were claimed by the village as whole, or rather the dominant clan of the village.

Among the shifting cultivators, the ability to claim private land was invariably linked with the number of adults in the family, so that a rich cultivator could get many wives and get people on payment to till his private fields or he would have to be a lucky householder to have many sons and daughters. There was hardly any tradition to hire labour on daily wages to cultivate land. The situation has been changing very fast in many communities, hitherto dependent on family or communal labour alone.

The frontier communities and the valley communities had a consi-

derably old tradition of working for wages. It was not unusual for better off Apa Tanis to hire workers on daily wages paid in kind for various agricultural operations. This, of course, went together with collective labour, which prevails even today. An interesting development is the entry among the shifting cultivators of limited daily wage labouring, where previously collective ownership of land combine with collective labour at the time of harvesting as well as slashing and burning operations and family labour for other operations was the rule.

Among the Apa Tanis, there was and is the institution of Patang or labour gang composed usually of an age set of boys and girls of a neighbourhood. The Patang worked collectively at the time of transplanting and harvesting of rice in the fields of the members' parents in rotation. For this labour, the family that got the group to work fed the members a mid-day meal and ice beer in the evening. Because of the entry of wage labouring, the traditional system of Patang has given rise to another, more popular form, Gouchi Patang, which involves work on harvesting and levelling during March to July on nominal wages but no mid-day meal.

Since Apa Tani economy was not a subsistence economy, there was the possibility of considerable surplus and hence also accumulation of wealth in a few families. These families used their surplus wealth to hire labour, sometimes the labour of the entire Patang to work on their fields. The payment was then made in kind. This also meant that some families could buy land off other poorer families, and also cultivate it with hired labour. This was thus a typical situation whereby primitive accumulation of wealth could happen. In the olden days, the media of exchange were rice and mithun. Land was bought and sold with mithuns and wages were paid in measures of rice. Land and mithun were also valued in terms of measures of rice. It is obvious that exchange transactions in terms of such "currency" were cumbersome and hence not too frequent. With the introduction of paper currency, the accumulation of land and wealth has become much more rapid.

Apa Tani, and the frontier Budhist societies, were, even in their traditional system, differentiated in terms of class and a modified form of caste. Apa Tanis, for example, were divided into guth or patrician and guchi or commoner classes. The divisions between these classes, though real in terms of ownership of land and housing plots closer to the village square (lapang), were less visible in terms of dress and styles of life. With the availability of bazar goods, expensive tailored suits and other industrial commodities, the rich among these communities can now maintain a conspicuously different style of life. The richer sections are also able to send their children to high schools, colleges and universities outside. The upperclass style of life has led to the creation of a class of tribal elite whose social and cultural aspirations link them to their class fraternity in other parts of India.

Increasing monetisation of the region has made it possible for the poorer, commoner segments among the tribal communities to get out of

their system of traditional interdependence and get cash wages on the road and building sites. However, since employment can usually be obtained only through a labour contractor, a part of the wages are surrendered to the middleman. The wage rates have, however, gone up in the villages as well. Thus, extension of the administrative frontier of the Indian civilization has resulted in accelerating the pace of changes in the following directions:

1. Increasing monetisation leading to weakening of the traditional system of inter-dependence.
2. Increasing use of bazar commodities, leading to visible differences in styles of life and the consequent sharpening of class differences where class differences had already existed.
3. Rapid growth of commercial entrepreneurial class among Apa Tanis and some of the other frontier communities which already had trading traditions. This means that the economic differences and consequently differences in status between different communities are becoming more obvious.
4. Differences in the development rates between different ethnic groups are becoming more visible due to the following factors:
   (i) Spread of English education and higher education among Apa Tanis and Monpas.
   (ii) Increasing use of political offices by the advanced communities.
   (iii) Employment in government offices and taking of government contracts, resulting in the growth of a capitalist class.

XIV

How are the changes in the social structure and culture related to energy system within the society?

Let us first have another look at the traditional sources of power. Although by and large the use of human power resources continues in the traditional ways, there are significant tendencies for change in this respect as well.

1. Wherever education has spread, there is a tendency among younger people to seek non-manual work, which is now more easily available in the government offices and some industrial and commercial establishments. The average age of the male agricultural labourer is, therefore, probably more than it was in the more "developed" communities, such as Apa Tanis and Monpas.
2. Since the traditional system still continues and requires of the families the contribution of labour in communal gang work, very often women are replacing men in the gang-teams.
3. Wood cutting and selling in the bazars is an additional source of continuous income for poorer people. This is being done on a far more extensive scale than hitherto. The newly growing urban population has an ever-growing demand for firewood.

4. Wherever possible, people avail of the generous help of the use of army trucks to go from the market to the nearest point on the road passing by their villages. Road transport buses are also available to carry some of the transportation which was previously done solely on human backs.

The use of animals as beasts of burden was limited to Monpas, Sherdukpen and related tribal groups. This is now supplemented by road transport.

Electricity was introduced in NEFA at the district headquarters during the 50's itself. Most of the generating sets were diesel run. Diesel sets for generating electrical energy were also introduced by a number of industries established during the 70's. Among the Sherdukpen, water wheels were used to dehusk rice and ground rice and barley flour. This ancient technology still exists, but its use is getting limited,.as diesel and electrical motors are becoming more popular. There is a programme of hydroelectric schemes. The elctrification programme is discussed in greater detail in Section XVI.

Wood provides almost the entire energy needed to cook and warm houses. Some kinds of tree branches are burnt for lighting the houses. These lights give out too much smoke and create unhealthy conditions in the houses.

XV

We have mentioned various factors which have tended to accelerate various modes of economic activity. Practically all of these have negatively influenced the forest dominated ecology of the region, leading to a burgeoning imbalance.

The extension of the roadways was the first step in the process of establishing a link between the NEFA region and the rest of the country. Building of roads means the transfer of land use of certain portions of hillsides and valley lands where roads pass. Cutting of hillsides increases the process of erosion and therely affects larger forest areas.

The establishment of transportation and communication network centred around administrative centres establishes a process of nucleation whereby the urban centres accrete many functions other than the ones originally envisaged. Increase in urban populations demands various kinds of resources from the hinterlands. Thus, the population at the nucleus receives large quantities of construction wood, firewood, vegetables, rice and meat. For the tribal population, this provides an opportunity to earn cash, which they can spend on textiles, jewellery, pots and pans, tea, kerosene, torches, bicycles, etc. This results in a still quicker decimation of forest than was occurring in accordance with the slow rhythm of the traditional tribal life.

As the urbanized tribals have more money, they can pay higher prices for beef brought by the other tribals to the market. There is a tendency to increase the livestock with the forest dwellers. This, in turn, increases soil erosion and slows down the rate of rejuvenation of lands which have been brought under shifting cultivation. There is also a tendency to extend the slash and burn cultivation and make the cycle of shifting cultivation of shorter duration. Thus, the temporary cash gains of the tribals are a permament loss to the delicate ecological balance.

After having adequately destroyed the forest resources of the Brahmaputra valley, the urban civilization of mainland India has now begun to focus its hungry eyes on the forest resources of the Eastern Himalayan region. A number of industrial projects based on the forest resources have begun to function and the large scale decimation of the natural forests is going apace. There are ten plywood mills and sixteen saw mills in the state. The Forest Corporation of Arunachal has two of these sawwood and plywood establishments. Ten are privately owned.

One of the effects of growing population of educated tribals is to increase the aspirational levels of the boys and their families. Many of them are eagerly looking forward to the establishment of District Industries Centres, where with limited investment of the family funds and considerable funds of the government, they expect to initiate indigenously led efforts at industrial development. No doubt, many of these industries will depend directly or indirectly upon the forest resources and thus lead to further acceleration of the process mentioned above.

The traditional style of using forest resources is also not frugal. For example, shifting cultivation is not the best form of land resource utilization. It is only less harmful when the population of the shifting cultivators is adequately controlled by high death rates. Now that government has introduced modern medicines and medical systems of health care through government hospitals, the death rates are beginning to drop and the rate of population increase has begun to climb. The higher population combined with an increased requirement for cash is contributing significantly to extended slash and burn economy.

XVI

If the process of slash and burn combined with indiscriminate commercial use of forest wealth continues unabated, there is a danger of the already low rainfall getting even less, leading to long periods of drought followed by flash floods. It is not an uncommon experience in human history where fertile forest lands have been converted to arid rainless regions — largely as a result of thoughtless attitudes towards the forests.

XVII

The rapidly growing demand for energy in the region cannot be satisfied by the diesel run electric generators. Since the north eastern region is very rich in terms of river water resources, various hydroelectric schemes are seen as alternative sources of energy.

In the initial phase of development, electricity generated by diesel power generators was meant primarily to serve offices and schools. Some of this electricity, within 10 km distance, was also utilized by the commercial consumers. By the Third Plan period, a number of micro-hydel schemes (MHS) of below 500 kW capacity were initiated and completed. Hydel power was much cheaper and each scheme added on the whole above 500 kWh electricity, thus making it possible to extend the operation of electrification to within 50 km of the place of generation. Thus, by 1975, a number of minor hydroelectric schemes (NHS) of above 500 kW were introduced. Today, practically all the major administrative, developmental and market centres within the region, as well as the central localities in many larger villages, are electrified. In the Sixth Plan, it is proposed to electrify 50% of the villages and after the completion of Kameng Hydro-electric Scheme (JHS), most of Arunachal will be electrified and electricity would be a major revenue earner for the state.

XVIII

To what extent can electrification be an answer to the major threat of forest degradation? Given the solutions to certain major problems related to the traditional ethnic as well as national cultural tendencies, electricity can only be a partial answer to the problem. In fact, initially, extension of electricity will lead to the acceleration of the ecology imbalance, since it will lead to faster and more extensive urbanization and industrialization. It is only in the second phase of development that electricity will begin to replace wood for heating and lighting in the homes. In the third phase, we can hope that shifting cultivation will be stopped and people of Arunachal will be fed only on the rice produced: (a) in the irrigated valleys, and (b) imported from the Brahmaputra valley. In this phase of development, the accelerated process of industrialization would have shifted the emphasis from subsistence agriculture to commercial forestry and horticulture. It is only with this shift in the pattern of rural-urban relations that ecological balance will be restored, at a higher level of technology and culture.

INTERNAL DYANAMICS OF SCIENTIFIC PROCESSES

SCIENCE AND ITS PRESUPPOSITIONS

Amitabha D Gupta *

This paper, I am afraid, will not reflect anything on matters concerning science policy and other related problems of scientific research. The reason is that the study conducted here is a second order study of science. That is to say, instead of dealing with any particular problem or aspect of science, it goes into the very presuppositions of science. A presuppositional study does not add anything new to the informational content of the first order study. It is essentially a critical study in the sense that it justifies and clarifies the foundation of the first order inquiry. The relevance of this paper, therefore, should be seen in this light.

Science being one of the greatest accomplishments of the human mind should not be seen either as a mere theoretical abstraction or as a tool to be used for bringing about a robust technological change. It is one of the modes of human knowledge and it presupposes a foundation of its own. In other words it is both a theory and a praxis or human activity. Lack of coordination between the two can lead to a state of alienation in science or what the famous German philosopher Husserl calls crisis in science.

This alienation in science or the alienation of scientific theory from its praxis has been recognized in recent times by people belonging to various traditions of thought and research. Researches in the philosophy and the sociology of science have shown the myth of the earlier or the positivist conception of science according to which the aim of science is to attain ideal objectivity—"an ideal that subjects all scientific statements to the test of impartial criteria recognizing no authority of persons in the realm of cognition"[1]. This view has been challenged and a new move has been taken which tried to discover the historical contingency of scientific paradigm. The popper-Kuhn controversy in the phiolosophy of science in this respect deserves special mention. Karol Popper, one of the principal exponents of the conventional view, argues that the growth of science follows a cumulative pattern. That is to say, science progresses step by step and is guided by its internal logic, which is independent of any social basis. Kuhn challenges this view. For him, science can be of two types — normal science and revolutionary science. Normal science consists of the articulation of the

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existing paradigm to which the scientific community is committed. Scientific revolutions on the other hand are non-cumulative which replace "order paradigm in whole or in part by an incompatible new one"[2]. According to Kuhn, the shift of paradigm depends on various historical, sociological and even psychological factors. The strict sense of objectivity can, therefore, no longer be maintained in science. Similarly, in some of the works in the sociology of science and particularly in the Marxist tradition of thought, the conventional view has been challenged. As a result, the new awareness came and that is the awareness to rediscover and redefine the foundation of science. Science is no longer considered to be an autonomous force. People felt that science is essentially social and it represents what Wittgenstein calls a form of life.

This paper essentially tries to redefine the meaning of science through a study of its foundation. The kind of study that I shall initiate here is different from that of Kuhn or Marx. My basic attempt will be to show how the original meaning of science was that lost through the period of its subsequent development. This deviation from original meaning is what I call the origional sin of science. The sin is the systematic rejection of the idea of reason according to which reason is both subjective and objective, theory and praxis and, therefore, it is an instrument for changing the world in accord with man's rational faculties and ends. But reason as constituted in science is reduced to paradigmatic rules of deductive inference. Scientific rationality is divorced from the rational humanitas and becomes a technological rationality without having any 'end' or tetos of its own. Galileo has never asked for the validity of the foundation of mathematics and its extension to natural science. For him, this whole question is an irrelevant one, since mathematics justifies its own foundation. In other words, mathematics is the science of the self-evident. Thus, science, as Herbert Murcuse observes, "Contained an unscientific foundation"[3]. Neither Marx nor Kuhn talks about this original sin of science. On the basis of the inadequacy of the conventional view, they tried to show the sociological and historical roots of science. This indeed provides a new perspective to the foundation of science. But this is not enough. One must see that the connection between science and human praxis is not a matter of empirical coincidence or fact alone, but it is a theoretical necessity. In other words, this connection is not just an external or sociological one, but it is something which is concerned with the very structure and meaning of science. The basic issue here is not the external relationship between science and society, but the internal conceptual structure of science itself. This is what I have said earlier that reason in its orginal state demands such connection. Modern science is a fall from that state and therefore there is a crisis in science.

Though this paper does not directly contribute anything on science policy, it does provide in an important sense a theoretical or foundational justification for research on science policy and social control of science. In

my analysis, I have been very much influenced by Husserl's work entitled *The crisis of Euroepean Science and Transcendental Phenomenology*. I have accepted his analysis, but I have not accepted his pnenomenological solution to the problem. With these preliminary remarks I now go into the main body of this paper.

THREE STAGES OF THE CONCEPTUAL DEVELOPMENT OF SCIENCE

The study of the history of science will reveal that the internal structure of science can be seen approximately in terms of its three-conceptual development[4].

Science as a new awareness

The first phase of science starts with Descartes approximately from the middle of the seventeenth century and it extends up to the middle of the eighteenth century. In his *Meditations on first philosphy*, Descartes first tries to provide a sure foundation for, and a validation of, the new science. For Descartes, the universe as it appears in experience does reveal its real nature and structure. The real nature of the universe, as Descartes claims, should be uncovered in exact mathematical terms. This poses a sharp contrast between appearance and reality—a reality that is conceived and constructed in mathematical physics. Descartes tries to justify this appearance—reality distinction by appealing to a principle which claims that whatever is clearly and distinctly perceived is true. Mathematical knowledge and particularly geometrical conception of the external world, as Descartes claims, justifies this principle. This marks the beginning of a new way of thinking and it is thus a landmark in the history of the conceptual development of science. One is aware of the fact that mathematical knowledge can provide a sure foundation to science. Science now starts as an independent inquiry, which no longer needs any justification or validation. This brings us to the second phase.

Science as a fact

This phase starts in the year 1748 with Leonhard Euler, the great Swiss mathematician. In his famous monograph, *Reflection on Space and Time*[5], Euler discusses the concept of absolute space, absolute time and absolute motion. In this scientific treatise, he makes certain claims which call for a radical change in our philosophical thinking. Euler agrees that philosophers must continue to discuss the fundamental concepts of physics, but which concepts are to be regarded as fundamental is a decision to be taken by the physicists and not the philosophers. In matters of scientific knwoledge, which is consequently identified as the only mode of knowledge, one must accept the supermacy of physics rather than phiosophy. If a physicist, for example, thinks that for the proper formulation of the laws of dynamics and

laws of inertia one requires a formulation of absolute space and time, then the inclusion of these notions should be accepted as valid. The validity and justification of these notions should be understood within the theoretical context of physics. consequently, in such matters, philosophers do not have any independence; they must accept the decision of the physicists as final and proceed accordingly. This given rise to a new conception of philosophy which is known as logic of science.

The above discussion shows that science no longer needs any justification. Its validity is taken for granted and thus science becomes a fact. That science is a fact is the central feature of the positivist world-view. A new culture along with a new concept of rationality came into existnce. Consequently, this phase — science as a fact — raises certain problems which reflect a crisis in the foundation of science. This marks the beginning of the third phase, which Husserl calls science as a problem.

Science as a problem

Science as a problem is the third stage in the conceptual development of science. It signifies certain basic changes in the internal structure of science. Modern science, or more appropriately the physicist's programme of the mathematization of nature, exhibits a structure that is similar to the structure of a machine. In other words, the entire procedure of modern science can be better understood in the sense of a logical machine which implies the algorithmic procedure used for the formalization of mathematics. These algorithmic procedures are purely mechanical in the sense that they can be applied in an absolutely routine manner. Methods of science, since they are rigorously formalized, assume the same character. This results in what is known as 'technization of science' which implies the mechanical application of scientific rules. Science can thus be compared with a machine which can be handled by anyone who knows the rules of the operation of the machine.

This view of science (i.e. physics) is totally abstracted from our everyday world of experience. But if we look at the history of science, we find that physics of the nineteenth century was not like contemporary physics. In the field theories of Faraday and Maxwell, one can see that the models used there have still some intuitive or visualizable content. This is not true of contemporary physics where models are of highly abstract nature and they are treated according to algorithmic rules of operation alone. This gives an instrumental character to the very structure of science. By the *logos* of pure science one now understands only technology whose purpose is to serve some external ends. This is definitely an irrationality of science.

Here at this stage, I think that one can make a basic conceptual distinction between a machine and a machanism that makes functioning of a machine possible. Mechanisms are, therefore, presuppositions of a machine. In a similar way one must see the distinction between galilean or modern science and the

presuppositions of it. It is those presuppositions which make not only modern science possible but also define its meaning. But these presuppositions would not be revealed if one adopts the view of a technician of science.

In order to inquire how science is possible, Husserl finds that it is geometry—the art of measurement —which is the presupposition of the entire programme called mathematization of nature.

Husserl[6] shows that the modern programme of idealization of geometry is rooted in the art of measurement practised by men in the *Lebenswelt.* This activity, i.e. the activity of measuring, is primarily governed by the pragmatic motives of man. That is to say, the purpose of this activity is to attain varying degrees of accuracy. It is through such activity that a carpenter, for example, transcends the horizon of practicality and attains some ideal notions, such as the idea of planeness or straightness in his system of understanding. These ideas are taken as ideals of perfection. They form the science of the idealities or geometry that represents the ideals of *episteme* of the Greek thought.

My purpose here is not to give an elaborate presentation of Husserl's analysis of the origin of geometry. Through this rather oversimplified exposition, I have only tried to show that this is perhaps a very significant way one can see idealization or axiomatization in science as part of man's intuitive knowledge of the world. The purpose of idealization in science is meant to interpret the physical world, and therefore it should never be mistaken as reality itself.

Husserl's analysis of the origin of geometry shows the primacy of life world over theoretical knowledge. Man's unstructured knowledge of the everyday world can be described as a - theoretical knowledge. This a - theoretical knowledge constitutes the very presuppositions of science which defines the meaning of science, i.e. science as human enterprise. The failure to see this theoretical dimension has led to a highly distorted view of science which I have described as technization of science. Scientific knowledge becomes mystified and consequently it is restricted within the hands of a few. This gives rise to a new brand of culture and elitism which are accepted as the most natural outcome of science. As a result, the third world countries are eagerly looking at west which symbolizes this new technocratic culture. Its impact on social science has been discussed in detail and I, therefore, do not want to go into it now. However, I want to point out that much of social science today suffers from the same original sin which I have mentioned earlier in the context of physical science. The crisis in social science has come because of its alienation from life world. A scientist, whether natural or social, is primarily an expert whose task is to give an objective assessment of reality. Thus, a batch of ballistic experts are primarily experts and as such will study the effect of napalm on their fellow beings without ever committing themselves to anything that is moral involved in this act of cruelty. In C.P. Snow's own worlds.

The tools may be used for purposes which most of us would regard as bad. If so, we are sorry. But as scientists this is no concern of ours[7].

The entire thing is justified on the ground that it is scientific. But this science, I must say, is a false consciousness. One must expose the scientific pretensions of these works. The experts are scientific in the sense that they only imitiate the surface features of science and thereby ignore the real problems with which they should be concerned. As a result, these experts very often take shelter in the pragmatic and methodological trivialities.

The above passage not only shows a total separation of theory from praxix, but also a separation of our intellectual from moral behaviour. This indeed calls for a new culture and a new perception, or, in other words, a self-conscious science.

REFERENCES

1. *Scheffler, I. Science and Subjectivity, Chicago University Press, 1967.*
2. *Kuhn, T. The Structure of Scientific Revolution, Chicago University Press.*
3. *Marcuse, H. 'On Science and Phenomenology'.*
4. *This three-level development has been suggested by Gurwitsch in his paper 'Galilean Physics in the Light of Husserl's Phenomenology'. Published in Galileo, Man of Science, ed. Ernan Mc Mullin, Basic Books, New York, 1967.*
5. *Euler, L. Reflexions Sur L'space et letemps.*
6. *Husserl, E. 'The Origin of Geometry', in The Crisis of European Sciences and Transcendental Phenomenology, trans. D. Carr Evanston: Northwestern University Press, 1970.*
7. *Quoted from Paul Baron, The Longer View, Monthly Review Modern Reader, New York, 1969.*

TEACHING ABOUT TECHNOLOGY : A CASE *

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SOME EXPLANATIONS

Neither the objective nor the content of this note is towards the assurance even for ourselves that an acceptable and satisfactory plan has been found for imparting formal instruction in this subject. Quite to the contrary, the motive to attempt the presentation has been a certain suspicion we have not been able to jettison along the way that in a relatively new field such as this, it is perhaps predictable that we are pleased with ourselves in anything at all we attempt as an academic exercise. The absence of universally acknowledged and well-understood definitions, conventions, boundaries, norms and yardsticks makes it particularly difficult for the individual academic to evaluate his own accomplishments more critically. We would welcome, therefore, an opportunity to share merely our experiences, limited as they are, but some of our doubts, apprehensions and uncertainties as well.

The science and technology couple has, of course, been in operation in civilized human society for a very long time. Academic explorations into the nature of the process are, however, relatively newer phenomena, with an ever-increasing number of formal courses, seminars and research projects directly or indirectly aimed at understanding the larger societal (and even global) implications of the development of technological institutions. It is not entirely improbable that as in the academic treatment of many other subjects of social significance, research and study on the subject of technology and society, also, might imperceptibly drift into schemata that are academically elegant or, in other words, conceptually cozy, reflecting the pat, pigeon-holed, value systems of the academic, rather than

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the realities of the very societal and global environment in which they are supposed to apply. We would like to record our acknowledgement in these prefacing remarks that such unnoticed and, perhaps, unintended drifts do occur, stressing at the same time that our awareness of the probability is no guarantee that it has not occurred in our own work.

In attempting to write on the subject on these lines, it became clear very early in the assignment that even in the limited task of sharing some academic experiences, the choice of foci available to us was wide. The canvas that presented itself was extraordinarily broad and vast, and seemed to demand of us an all-or-none view. For instance, how could we, if we chose to, discuss

- questions of academic content, without the necessary excursions into the related theoretical issues, the state-of-the-art reviews, a critical examination of the Indian context and needs, and so on? And how could we do those things without raising
- questions of method, course structures, practices, research assignments, and such other pedagogical details? And how, in turn, could either of these facets be discussed without
- the epistemological facet, stemming off into the legal, political, ethical and philosophical questions?

While we could take comfort in the fact that the assignment itself was to be far less ambitious and the writing to be far more compact, it seemed worthwhile nevertheless to constantly visualise the whole canvas within which any such limited narrative might be placed. What follows is, therefore, much more in the nature of a case study -- being presented unrehearsed, first-draft narrative of some experiences -- being presented unseparated from the reflections, questions and issues that we have at times had to recognize. In the past we have found it useful to listen to the experiences of others in a similar, integral manner; we wondered on the possible usefulness of more such exchanges among interested others.

EVENTS AND OPPORTUNITIES

It needs perhaps to be stated that two important sets of factors might have contributed to the particular line of development that we are setting out to describe: first, the background disciplines of the two authors, especially their inherent inadequacies, and the resultant dissatisfactions with the prevailing understanding of the processes of social change -- a common concern identified early; secondly, the opportunities afforded by an academic environment that can only be described as liberal, for they would be difficult to come by in many other settings. With several new institutions and several groups in existing institutions turning to studies in the area, Bangalore has emerged as an important centre for activities connected with

questions of technology and society and we have had the benefit of interaction with several individuals, institutions and visiting scholars in a wide variety of endeavours.

The events and opportunities were many. Their listing and description below is kept deliberately brief. The object of the listing is not merely the factual record, but to remind ourselves that most events may be viewed as precursory to other events, and that little bits of observation and insight often remain scattered within individual experiences until other opportunities can be found to bring them together in a more unified form.

EXPLANATORY WRITING

Whether in the form of a tentative discussion note or a case study or a publishable paper, ideation seems to have a better chance of providing a learning value (through feedback, criticism and comment) if it is put down on paper. We have had our attempts in a number of settings. Some of them were :

- A chapter for the ICSSR sponsored survey of research in psychology, which, in effect, was a position paper on the environment and social issues[1]. It was the first attempt to explore the interfaces between the discipline backgrounds of the two authors and to seek conceptual and practical links for collaborative effort.
- A paper for a seminar on science, technology and rural development[2] in which we attempted to show (a) the inevitability of the bind between choice of technology and the larger quality of life in rural development, and (b) the nature of the intervention process in attempting social change via technology.
- Individual writing by one or the other, either by himself or in collaboration with others, in which the technology-society bind continued to be the underlying theme or was developed more deliberately, e.g. in writing about
  - appropriate/alternative technology in the context of development[3];
  - the history of the management movement in the country[4] in which transfer of technology was seen playing an understandably significant role;
  - the social cost benefit analysis of third level (feeder) air services in the country[5]; and
  - the links across various system levels of industrialized activity with reference to both the setting of priorities and the monitoring of their implementation by the target groups[6].

EARLY TEACHING

Of the earlier attempts to introduce discussions on technology and development formally into a post-graduate course structure, a few may be mentioned:

- The first fellowship (doctoral) programme at the Institute. The first author was required to take a course in organizational behaviour, but he chose to experiment with both content and structure in the course (especially since the fellowship programme at the Institute was avowedly 'sectoral' in its orientation and, in fact, called the course 'OB and Social Change'. The second author, being required to provide an introduction to Indian economic conditions, chose to similarly introduce discussions on processes of continuing underdevelopment and the problems of social change. Both were structured as seminar courses. They ran parallel, with concepts dealt with in one course having implications for the coverage at that time in the other course and, indeed, the two streams were brought to a confluence, by design, into common seminars in the last quarter of the course work.
- Two batches of students undergoing the post-graduate programme in management (equivalent to MBA) took a course titled "The Indian Industrial Scene and Choice of Technology" (IISCOT). The objective of the course was, of course, to demonstrate the inevitability of the processes of development (or underdevelopment) being associated with the choice of technology at various system levels of planning and the course resorted to case studies of projects and also involved field work for exploring alternative and appropriate technologies for specific communities in and around Bangalore. (This effort has since been institutionalized into the curriculum as the Social Involvement Project.)
- The reality and the omni-competent quality of the technological context was discovered (by deliberate exploration) in even the "conventional" post-graduate courses such as Indian Economics or Organisational Behaviour or Industrial Psychology[7,8].

RESEARCH AND RELATED EXPLORATIONS

Three main events need to be included here. They differed widely in their origins and their specific contents, but their research basis was evident in their objectives having planned explorations in fairly well-defined boundaries of study.

- Following the scope of planned intervention suggested by the IISCOT case studies, the Karnataka State Council of Science and Technology sponsored a research project in the form of a pilot

study to examine the feasibility of introducing a men-land-based economic activity (through an appropriate technology) in a rural district near Bangalore[9].

- The Indian Council of Social Science Research (ICSSR) sponsored a "Workshop on Rural Socio-Technical Systems". The participants (over 20) were all (a) Doctoral students, (b) engaged in research that would directly or indirectly be related to community (especially rural) intervention and change, and (c) likely to benefit from interdisciplinary and systems approaches in studying rural communities[10].
- A seminar was convened at the Institute in 1978 on "Technological Choice in the Indian Environment". The contributions and discussions covered as wide a spectrum as conceivable with respect to technology choice in the context of development: from regional development through housing to medical and health services[11].

ASSIGNMENTS AND WORK OPPORTUNITIES

Starting January 1979, the second author found in his assignment as economic adviser to the National Small Industries Corporation (on deputation from the Institute) the opportunity to both test various academic assumptions of development through alternatives in the industrialization process and, perhaps more important, to understand the governmental and administrative processes that need to be considered side by side with planning exercises. [In other words, the (technology) transfer process may be viewed as a complex activity starting from technology diffusion in research laboratories to field trials and commercial diffusion in specific industrial settings in backward areas][12].

In this period, the first author was associated with the work programmes of two voluntary agencies generally concerned with development education. In one of these programmes, an experimental syllabus was attempted towards "development consciousness" among pupils of school-leaving classes. The role of technology became obvious in almost every discussion theme, such as housing, employment, transport, education and life-styles[13].

MORE RECENT TEACHING — SPECIFIC FOCI

While all of the earlier assignments might be treated as explorations of one kind or the other around technology, two recent courses formally conceived and included in the curriculum of the Centre for Habitat and Environmental Studies at the Institute might be considered for their direct and deliberate references to the introduction of appropriate technologies, especially for

rural development. Both these courses were influenced, naturally, by the experiences thus far. The courses were :

- The elective course on Rural Socio-Technical System (First author).
- The elective course on Appropriate Technology (Second author).

Brief outlines of the two courses are provided as appendices. Needless to say, the courses can hardly be considered as the final products, for as in the past, the preparation and conduct of these two courses have had feed-back influences on the instructors themselves and they find their conceptual research in this field unending.

ON METHOD AND APPROACH

We would like to make three specific observations and seek the experiences of others in this regard.

(1) We found the highest learning value in the courses in the activity-based, experiential, participative methods and techniques employed—field projects, seminars, research exercises, and so on. The participative approach also implied a willingness on the part of the instructor to learn with the participants, rather than to restrict himself to the role of teaching to them. The approach seems to have the additional value of generating outputs that might be useful in other ways, such as case studies, position papers and reviews.

(2) The deliberations in the course work cannot help becoming genuinely interdisciplinary--not merely multidisciplined, a distinction we are not tired of stressing -- and the consequent search for interfaces is a valuable experience even if at times frustrating. The significance of systemic and holistic ends emerges clearly and with near certainty.

(3) Considerations of technology and development cannot be separated from the subject of future actions and social change. Therefore, it becomes imperative that sufficient exploration is made into the growing body of literature on intervention -- assumptions, theory, techniques and problems of implementation.

SOME REFLECTIONS

Perhaps an appropriate start to this section would be with a link to the previous one. Another good reason to open the discussion here with this particular link is that several other questions and issues in teaching about technology seem to be manifestations of this basic observation.

Is a course on the nature of societal influences from technology to a group of postgraduate students not itself an intervention?

It must be evident that a list of second order questions appears charged and ready to spring out the moment the first question is answered -- whether

in the affirmative or in the negative. We have also observed, both in ourselves and in our colleagues and friends, that the more readily we plunge into the questions, the greater is the search for justifications for the position taken. In other words, it would appear that for many of us in academia, there is not a clearly thought out position to start with, and that, whatever the reasons, the discussion on this topic is a trifle uncomfortable. Can it be unusual if in these circumstances much of what is mustered and put forth as arguments is "dissonance-reducing" in its true character? We have ourselves undergone painful confrontations with inconsistencies in thought, word and deed, and it would be quite incorrect if in raising this question we appear to be suggesting that we have overcome them all.

Our present position, admittedly a balancing act, needs not to be elaborated upon at this stage. We have dared to attempt a more explicit statement that comes later. Meanwhile there are other, related, questions with regard to academic programmes in this field that we have found necessary to recognize as requiring attention. In considering these questions, we discover, once again, that in designing and carrying out academic programmes -- teaching or research -- the aspects of content, method and context cannot be dealt with individually and separately, although listed so for convenience.

CONTEXT

Teaching about technology (appropriate, alternative or any other variant) and all related academic excursions seem to acquire greater meaning only if technologies and their choice, evaluation and benefits are considered within a larger societal context. An analysis of an "appropriate" technology may thus be made either within the framework of an engineering science or in a social science framework.

Some special considerations in the context of third world/less developed/poor countries that seem relevant in the design of academic programmes would be:

- Wide socio-economic disparities and increasing inequality between an elite minority and the rest of the population.
- Following from the above, a vicious circle of selective "development".
- Large percentages of the population below poverty lines drawn by any index available.
- The unavoidability of dealing with political dimensions, in their broadest sense, in the examination of any development programme; more so if new technologies are involved.
- The implications of the observations above in the two population strata that matter most -- the rural and the unorganized sectors.

- The structures and the functioning of administrative agencies responsible for development programmes, especially the common incongruence between the political and administrative wings of government.

Conflicts and ironies of a contextual nature extend into institutions and classroom as well.

- The student group (certainly in the post-graduate management courses), often the cream of the country's graduate crop, is drawn very heavily from the very strata of society that are seen as perpetrating the prevailing lopsided development.
- These students also have future roles as managers in which it is very unlikely that their opinions on the assessment and choice of technology, on alternative developmental criteria ,will matter.*
- Indeed, it would not be uncommon if a developmental concept or, say, the rationale of a social cost benefit index actually conflicted with another concept or technique in the marketing, production or personnel management courses.
- The comment on background and upbringing is applicable to the teacher as much as to his students. After all, our own exposure to rural systems (and other disadvantaged sectors) through any sustained field work was only after we joined this Institute. Our clumsiness in a field trip continues to be no less than that of our students.

And yet, all things considered, we need also to note that such academic programmes can be conceived, toyed with, frequently modified and sustained only in such institutional contexts: they stand little or no chance of progressing beyond the staff room, under the given circumstances, in the more conventional educational streams.

CONTENT

In almost any academic discussion on technology, the classroom not excluded, the communication blocks that one notices in the initial stages stem from two main sets of predisposition among the participants:

- Differences in foci--specific orientations often being polarised into issues such as
- urban vs rural application
- macro vs micro scale
- public vs private enterprise
- transferred vs indigenous and so on.

**To take but one live example out of many, how does an alumnus of the Institute working in the planning cell of a large engineering industry apply social-cost-benefit analyses in evaluating a licensing proposal when the specific brief given to him is to justify it?*

In the classroom, more than in other settings, the confusion that results from so many classificatory schemes needs to be tackled patiently and sympathetically, while yet maintaining the search for a larger, more comprehensive, taxonomy of technologies even within the generally appropriate ones.

- Differences in the underlying assumptions are more difficult to spot, for often they are not articulated as theoretical propositions; but they reflect, nevertheless, the values, ideologies and world views that govern our lives.*

We would hasten to add that we do not regard these conditions as difficulties or obstacles. The search for clarity among conflicting assumptions and emphasis without an available pedantry might in fact be regarded as valuable in itself. However, we have relied on two approaches that seem to have been useful for the participants to reconnoitre the conceptual jungle† by themselves.

(1) A good introduction to General Systems Theory and familiarisation with the systems approach. The cross-sectional as well as the historical links among events, institutions and artifacts tend to be less perplexing and more explainable and, therefore, at least more predictable for the future.

(2) A more than cursory introduction to intervention theory, including a critical review of the available concepts, strategies, tools and techniques.

One other observation might be made while we are considering the content of a teaching programme. In keeping with the very systems approach that we promote, it would be desirable for the instructor to specify (and justify) in advance the particular system levels at which the discussions on intervention through technology are to be focussed. While as a theoretical exercise it should certainly be possible to draw system links all the way from the village smithy to the investment decisions made by agencies like the Steel Authority of India Ltd., the system levels at which most change agents (undergoing such courses) will find themselves operating may be expected to exist within a narrower band in the middle of the spectrum. This

**For instance, the grassroots activists' conviction might reflect, in one case, a disenchantment with the governmental/administrative machinery, a personal missionary motive in a second case, and in a third case a political ideology working towards structural change.*

†The baby bath-water paradigm as it applies to several technologies may be re-examined in this light. To take the most cited example, does the Green Revolution technology "cause" aggravated inequality? Or are there system predispositions that will aggravate inequality with any new Technology – high, intermediate or low?

is, of course, more easily said than done; for precisely in drawing boundaries in intervention lie the possibilities of unforeseen and unfortunate systemic consequences.

METHOD

The immediate and the most obvious discovery that one makes on entering this field of teaching is of the limitations of didactic instruction. This observation might in fact be made about all postgraduate learning; but it seems particularly applicable in the case of students setting out to discover the technology-society bind and, even more to strategies for possible control of the processes in the future; perhaps the difficulties are inherent in the nature of the subject matter

- the demands of abstraction for concepts invoked (e.g. dependency, transfer or even underdevelopment).
- the intangibility of historic-political realities and their unseen influences.
- the difficulty in comprehending society-wide long-term consequences, the selective monitoring and communication of consequences, and so forth.
- the inaccessibility of documents, records and institutional data for alternative analyses and illustrations.

Participative methods are an answer, but the intent alone can hardly get us anywhere. We need case studies, very many more of them. There seems to be no particular shortage of Indian experience in developmental projects involving various types of technological intervention, but so little of this seems to be available in a suitably documented form[15]. And additional benefit from careful documentation is the possibility of constructing simulation games and exercises which are unquestionably effective learning aids.

Participative methods are not without their own (systemic!) strains. Almost invariably such an approach calls for (a) long, sustained periods of application, whether in the classroom, library or field, and (b) a leisurely pursuit of the subject matter. Neither of these demands is compatible with the structures and schedules of a typical post-graduate management programme. It must be interpreted as a credit to our students that they have (so far) accepted this as yet another conflict to deal with in their undertaking our courses, and have (so far) dealt with it satisfactorily.

One last comment on methods might be in order. It should be possible for the academic to involve several other non-academic but relevant individuals and institutions in his programme -- entrepreneurs, financiers, governmental agencies, planning cells, R&D laboratories and others. We have not ourselves accomplished such a network of involvement yet, but that is no reason why we should not continue our efforts.

THE UNFINISHED BUSINESS

There is a predicament common to many in academic institutions, especially in teaching, and most prevalent in the social and behavioural sciences. This is in the sudden helplessness that one faces when one's analysis of stage of diagnosis to the stage of prognosis admits that our conceptual and technical skills to project into the future are yet far from adequate and our societal apparatus to manage the system towards those ends is even less so; hence the academic's compensated vigour in opinionation on matters leading up to the present. This in itself need cause no alarm, for there is scope for critical analysis of the past even as we look to the future. However, the real danger of such a stage is in the academic withdrawing into a defensive position, and the well known consequences of the such a position. Among other things, he gradually loses sight of the system links between himself -- the academic institution -- and the other institutional systems in his society. His own work, then, cannot help slipping into a routine in a cyst-like isolated existence.

We do not believe we have anything like advice on the matter, let alone a prescription. We have had our share of struggle with our academic identities, as we are sure most others have had with theirs. What we have picked and outlined below are a few limited objectives that we have set for ourselves within the academic institutional setting, quite apart from whatever objectives we might adopt in other institutional settings as individual members of the society. We believe that our efforts in these directions are at least not incompatible with efforts and developments in other settings. With some luck they might be appropriate supplements.

- As teachers, we need to identify more explicitly the ends we seek within the roles prescribed by an educational system. We would like to phrase this objective in the following manner:

The re-education of an elite minority that forms or will form the influence and opinion making groups in the society.

We are, of course, aware of the numerous interpretations that can be given to the position taken above and of the highly debatable character of the statement; but it is a statement carefully chosen and put into expression after considerable deliberation. Difficulties and obstacles in the pursuit of such a task pose challenges to pedagogic ingenuity, but cannot dislodge the objective itself. For as long as large number of people all around us continue to equate progress and development with cars and super-highways, blenders and washing machines, and TV antennas on roof-tops, we believe there is a job for the academic in re-education.

- As researchers, we need to organize our studies in a more purposive way through well dovetailed programmatic investigation. Correspondingly we need sustained effort in theory building. Examples of areas for such effort would be:

- recursive modelling across system levels in processes such as dependency, under-development and crisis intervention;
- alternative models in historical analyses and a reconstruction of the histories of developing and underdeveloping societies;
- towards alternative theories of planning.

- As professionals, we need to forge links with others committed to developmental ends and look upon plans of social action as a professional responsibility. In this point too, as in the first, we are accustomed to a certain amount of alarm in the ensuing discussion, but the rationale of collective professional action as an alternative to the purely opportunistic should not require much elaboration.

NOTES

1. *Padaki, V, V Vyasulu: On the Environment and Social Issues: Towards an environmental psychology; in the Second Survey of Research in Psychology in India; ICSSR.*

2. *Wasulu V, V Padaki: Employment, Rural Development and Social Change: in S. Radhakrishnan (Ed); Science and Technology for Rural Development, Madras, COSTED.*

3. *Mostly by the second author, V. Vyasulu: for example the Impact of Modern Technology on Underdeveloped Societies, Economic and Political Weekly, August 1976, Aptech vs Altech, EPW, August 1979.*

4 *Padaki V: The Management Movement in India: Towards a critical history: Review of Management, Economic and Political Weekly, 1981.*

5. *Ramakrishnan, K, V Padaki: Feeder Air Services: Feeding whose needs? Discussion Note, Later Published in Deccan Herald, 9 June 1980.*

6. *Kannan, T S, V Vyasulu: An Alternative Strategy for Employment and Rural Development: UNITAR conference on Alternative Development Strategies and the Future of Asia, Delhi: March 1980.*

7. *The lecture notes presented for the first such course ~~on~~ Economic Development took the form of the book The Paradox of Static Change by V Vyasulu; Sterlir 1978.*

8. *For instance, in dealing with the topics of job satisfaction and motivation, students might undertake studies of people in the unorganized sector – construction workers, cobblers, rag pickers, and so forth – and attempt scenarios of community-wide, systemic consequences of such interventions as industrialized, mass-produced, housing, or the proliferation of washing machines in homes.*

9. *The work in this particular hobli (revenue cluster of villages) has resulted in much documentation: e.g. Krishna A M (Ed), Managing the Choice of Technology, Choice of Technology Group, Bangalore 1978; the Mahadevpura Team, The Mahadevpura Eco-development Project, Proceedings of the ICSSR Seminar on Action Research, October 1978: Reddy, G. Narayana, Interaction Process in Development: Aspects of life in Kenchenkuppa, IIM, Bangalore 1978; Ribeiro, Mauricio A, Habitat and Technology Transfer: A progress report. CHES, IIM, Bangalore, 1978. Further work is in progress.*

10. *Padaki V, V Vyasulu: A report on the workshop on Rural socio-technical systems: Centre for Habitat and Environmental Studies; Indian Institute of Management, Bangalore, 1979.*

11. *The proceedings are now published; Vyasulu, V(Ed.): Technological Choice in the Indian Environment: New Delhi: Sterling 1980, also relevant in this context is the IIM , Bangalore seminar at which this paper was first presented, organised by J. Bandhyopadhyaya, and the various writings of Dr. Bandhyopadhyaya, available in the IIM library.*

12. *Vyasulu V, Link between large and small in Indian Industry Seminar, Madras Institute of Developmental Studies, 1979: Revised, EPW, Review of Management, August 1980. The basic approach is also revealed in the National Small Industries Corporation document towards Development of Koraput District in Orissa, May 1980: on "The Orissa Aluminium Complex: Pointing for Debate", with Kannan Srinivasan - And S. Rajagopalan in EPW, 12 December 1981.*

13. *Reported in Environmental Studies and Approach: Bangalore SEARCH, 1979 (restricted circulation).*

14. *Paul Baran's classic, "The Commitment of the Intellectual (Monthly Review, May 1961) sums up the basic dichotomy discernible in the value systems of academicians. It appears particularly relevant in the management and technology, faculties - the approach of the technician, problem-solver vs the approach of the systemic visualiser.*

15. *One or a series of "Case workshops" is a possible line of action. One such workshop has been planned by the two authors.*

Appendix 1 — RURAL SOCIO-TECHNICAL SYSTEMS:

The Management of Change

General

From the earliest observations on the social and psychological dimensions of a technology of coal mining to present-day formulations in intervention theory, the field of socio-technical studies has grown at a considerable rate.

What was once an exploratory idea has now come to be established as a major field of study, worthy of full time pursuit.

Socio-technical studies are concerned with the functioning of organizations and, ultimately, with the design of organizations. The system-level may vary from small, autonomous, units (such as a family in a cottage industry) to an entire village or community.

The management of organizations, in the broadest sense of the term, is facilitated by a holistic and systemic view of the various interrelated social and technical sub-systems, their unique and essential evolutionary history and extrapolation of the alternatives in consequences in planned change.

Such a study is unavoidably multidisciplined. Studying the productive/economic structure of a given social system from the perspective of its social-cultural history is not merely an activity of academic interest; it is most relevant for any planned change.

The course may be regarded as an attempt at purposive integration of several functional analyses provided to the students in the 2-year PGP and, therefore, as a natural culmination of the programme.

Extending studies in socio-technical design from the "factory" to the social systems in "alternative sectors" is not only in line with the avowed objectives of IIMS policy, but a promising avenue for future courses of action in rural development.

The course will follow upon the experience gained in the conduct of the workshop on research methodology for rural socio-technical systems commissioned by ICSSR.

RURAL SOCIO-TECHNICAL SYSTEMS: The Management of Change

Study/seminars	Lectures/tutorials	Project work
History, roots theoretical streams	Theoretical interlinks	Desk research
Developments - formal work organisations	Economic interface	Field work case research
Developments - other organisations	Technical-techno-logical interface	Methodology for socio-technical studies

Related conceptual frames - Technology, intervention, eco-development, OD, quality of life, etc.	Social-psychological interface	Integrative write-up
Implications for change - social change	Cases, case analyses	

Conduct of Course

Since the course involves a certain amount of field work, the total time available for the course will need to be utilized by the students (and faculty) in a more flexible schedule.

Assignments will include :

1. Case analyses
2. Field work for the preparation of fresh cases or case leads.
3. Classroom book-review seminars to cover the essential literature on the range of concepts and approaches.
4. Term papers covering the following :

- Approaches and assumptions in rural development
- Development and underdevelopment — a global, historical perspective
- Measures and indices of development and quality of life — A review.
- The approaches and contributions of OD and CD to intervention theory
- Appropriate, alternative and intermediate technologies—a socio-technical perspective and assessment.
- Ecology, environment and ecodevelopment.

Appendix 2 - TECHNOLOGY, SOCIAL CHANGE AND ECONOMIC DEVELOPMENT IN INDIA: TOWARDS ALTERNATIVES

The object of this course is to briefly assess the various strands of the "Western Model" of economic growth upon which the Indian planning effort has been based, with specific reference to its impact on different classes of the Indian people, and as they relate to the interface of science, technology and society. On the basis of this assessment which will be a collective effort of all concerned with the course, policy alternatives, and problems of implementation will be examined in specific terms in the Bangalore region.

The region of study will be Bidadi area of Ramanagaram Taluk, where the Institute has already done some work through student projects.

The alternative technologies studied by the earlier batch of students will be taken up for more intensive examination from the organizational and implementation points of view in an alternative development strategy.

The course will, therefore, consist of three parts:

1. The Western Model
2. Indian experience with the Western Model
3. Case studies.

Work on the case studies will be initiated right from the beginning of the term, since familiarity with the region is essential for field work. The final third of the course will focus on case studies.

1. The Western Model

The technological revolution of Western Europe and North America has led to the acceptance of certain basic notions on science, technology and economic growth. These will be examined briefly. (Examples of essential reading provided).

2. Indian Experience with the Western Model

Post-independence policies have built upon one strand or other of the Western Model. The impact of these policies on different groups of Indian society will be examined. (Examples of essential reading provided).

3. Towards an Alternative

There are no generally agreed-upon sets of alternative policies that meet all the tests of consistency and practicability. Yet, Indian literature has a fairly vast store of ideas and suggestions on the basis of which policy options may emerge. It is also clear that any alternative policy must include certain elements, as they seem to hold the key to social transformation. These are rural development, appropriate technology, mass participation, decentralization, reduction of inequalities, environmental protection and conservation, basic needs fulfilment, etc.

These elements and their inter-relationships will be discussed and used as the basis for the case studies in Bidadi (Examples of reading provided).

4. Case Studies

To be finalized in discussion in the first week of classes.

The course will be evaluated on the basis of book-reviews/class presentations and the final case study. Details will be finalized in the first week of classes.

TOWARDS A NATURALISTIC PERSPECTIVE ON SCIENTIFIC AND TECHNOLOGICAL PROCESSES

Arif A Waqif*

I. INTRODUCTION

The purpose of this paper is to review critically the two major perspectives on scientific and technological processes which are most commonly accepted and operative among practitioners and users of science and technology[1]. We then pose a third alternative based on a naturalistic and organic perspective of social processes, including scientific and technological processes. In the context of this perspective, we attempt to identify some basic concepts which help us interpret and understand the scientific and technological processes more holistically, organically and naturalistically. Finally, we illustrate the applicability of this naturalistic perspective by making some pertinent observations on Indian and Japanese economic and social histories.

II. THE EXPERTS' OR SCIENTISTS' PERSPECTIVE

(a) What it is supposed to be :

Ideally, the experts' or scientists'[2] perspective on the scientific and technological processes is derived from the acceptance of the basic tenets of what is commonly known as scientific temper. The components of scientific temper include the spirit of free enquiry and observation from nature and society, analysis of these observations based on commonly accepted scientific methodologies, and conclusions derived therefrom. In addition, the acceptance of scientific temper also pre-supposes the repeatability, confirmability and uniqueness of scientific solutions and truths, as derived through the use of scientific methodologies. Finally, the most important and attractive component of scientific temper, at least to some observers, is the value-free and objective nature of scientific and technological processes.

(b) What it actually is :

The following observations on what the experts' perspective actually turns out to be in reality come closer to representing the true nature of the interface between society and science and technology[3]. First of all, it is

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generally observed that experts and scientists do not always agree about the uniqueness of scientific solutions or answers to problems of nature and society. Not only is there disagreement about what is scientific truth among scientists and experts of different disciplines, we also find that experts even in the same discipline are often likely to disagree on what is desirable from a purely scientific and technological perspective, let alone from a social perspective. Secondly, the assumption about the value-free nature of these processes is not actually realized in practice. Not only do scientists have conflicting views about the nature of scientific truth, they also have conflicting values which affect their perception of scientific truth. To the extent that the values and the value systems of the scientists and experts are not made explicit, experts are left free to propagate their own personalized or fragmented ideological positions. Thirdly, the experts' perspectives are often not independent of the institutions with which they are affiliated, the extent and nature of funding for scientific and technological activities, and administrative rules about secrecy and sanctity of certain activities, data, etc. Fourthly, the experts' perspective also depends on or is influenced by the professional and interpersonal rapport existing among experts in various disciplines as well as in the same discipline, and the potential for consensus building on scientific and technological issues. Finally, the expert's perspective is coloured by his/her own desire for fame, publicity, pecuniary benefits, careerism, social identity and status, and mental and emotional peace; by the nature of professional and research habits acquired through training; and by his/her perceptions and prejudices about other groups in society. These factors lead to politicization of scientific and technological processes. This politicisation is characterized by the experts' tendencies to use knowledge as a political commodity, to develop professional consensus on scientific and technological issues considered important by the experts, though perhaps not by society, to form coalitions both within and outside the scientific and technological community to support or reject specific scientific and technological ideas, and to develop access to the socially and politically powerful.

(c) Social implications:

When the experts' perspective is characterized by the above-mentioned factors, it has several developmental implications for society[4]. The most important of these are as follows. Usually this perspective does not automatically encourage the systematic consideration of who performs scientific and technological activities, for whom, and as a result who gains and who loses in society. Furthermore, the experts' perspective is likely to polarize views on society into the experts' perspective and the layman's perspective or the modern vs the traditional perspective, or the scientific vs the non-scientific perspective. In this respect, the experts' perspective winds up often not appreciating that the dividing lines between these sets of polarizations are far from sharp and clear-cut, and that elements of one perspective are often to be found in the other. Futhermore, the experts' perspective is likely to be characterized by elements of scientific

universalism, determinism, centralism and urban-elitist-technocratic biases. Finally, the politicization of scientific and technological activities is often skewed in favour of certain classes and does not automatically lead to the attainment of socially desirable goals. It is worth considering the views of some well-known thinkers in this regard. For instance, Schumacher[5] holds that we need to evolve meta-economics, or to extend his view further, meta-science, to help us observe, analyse and understand man's relationship not only to his material needs but also to his non-material needs and his potentialities and limitations. Other writers like John Stuart Mill, Hobson and Gunnar Myrdal, to mention just a few, have in various ways exorted scientists and social scientists to study not only the physical and economic processes, but also to understand the linkages of these processes to psychological, social, political and cultural processes. On the philosophical side, Henry David Thoreau has observed that a specialist would have you view the sky through a narrow skylight in a roof, while it is the whole heavens you would rather see.

III. THE USERS' PERSPECTIVE

(a) What it is:

This perspective is the one which is commonly held by resource owners, managers and administrators. The components of this perspective are based on the perceptions of the effects of scientific and technological activities on the efficiency of production, distribution, consumption and investment. More specifically, it is likely to be characterized by considerations related to private and social profitability, capital formation, growth and other material indices of economic and social welfare. Another component of this perspective is the users' concerns about the nature of economic motivations and incentives for scientific and technological activities, and institutional conditions for exploiting science and technology for personal as well as collective gains. This perspective is very frequently dominated by potentially quantifiable cost-benefit considerations, which provide decision-making rules for allocating resources for scientific and technological activities.

(b) How it actually operates:

Ideally, the resources for scientific and technological activities are allocated on private and social cost-benefit considerations, as pointed out. In reality, however, these decisions are more likely to be based on political-economic considerations which are likely to be coloured by relative bargaining strengths of various interest groups who stand to gain or lose from specific or general scientific and technological progress. This is because scientific and technological activities are not economically and politically

free. Because of the political nature of how costs and benefits are perceived and prioritized by different groups in society, this perspective frequently results in unequal distribution of benefits from science and technology. In addition, it provides justification for various forms of exploitation, human displacement, drudgery and alienation in the name of scientific and technological efficiency. Furthermore, such a perspective is likely to reduce productive jobs and increase coordinative and integrative jobs, thereby reducing opportunities for individual achievement, pride and satisfaction from work. Finally, such a perspective is likely to promote a monolithic scientific and technological culture wherein people work, live, dress and eat more or less like one another.

(c) Social implications:

Various social implications follow from this users' perspective. For one thing, this perspective sometimes fails to appreciate that in a social context science and technology have to be perceived not as ends in themselves but as means to achieve social objectives; that by sheer numerical proliferation and velocity, technological means of production and organization unavoidably surpass man's relatively unchanging biological, emotional and spiritual capacities"[6], that the socially uncontrolled development of technologies in the nuclear, computer, drugs, genetics and transportation fields has potentially dangerous future social implications; and the need to control potentially dangerous technologies often results in increasing state control and decreasing human freedoms, or it results in more technology[7]. In this context, Schumacher, for example, has argued that scientific and technological activities should lead to making the work environment more pleasant, productive and creative, and not to the elimination of work; that they should help human faculties at the same time that they facilitate the production of goods and services; that they should be non-violent to man and nature, i.e. they should not disturb the natural rhythms and patterns of life or create conditions in which man is likely to become unnatural; that these activities should lead to cheap and simple technologies available for every one and not just for the rich and the powerful; and that such technologies should be decentralized and based on self-help, self-reliance and local needs and resources[8]. A common thread of argument along these lines can be found even when Gandhi and Marx are interpreted together. Both of them, for example, would perhaps accept a society governed by science and technology if: no surplus labour or under-employment exists; if the domination of science and technology does not result in concentration of income, wealth and power; if work for all can still be made more interesting, challenging, creative and fulfilling; and if institutional changes necessitated by the dominance of science and technology consider human needs as most significant. Along the same lines, Ellul[7] has said that man should recognize

the forces of science and technology and should be able to control them rather than allow himself to be controlled by them; that he should recognize the psychology of scientific and technological culture by seeing through the traditional rationalization of science and technology and the material and international interests that advocate such culture. Another interesting warning comes from Mishan[9], who has argued that instead of drifting into a future dominated by science and technology, man should adjust the technological environment to his natural needs and capacities; and that man may even consider the possibility that though scientific and technological progress appear to be inevitable and unstoppable, the needs of men and the needs of science and technology may sometimes prove to be irreconciliable.

IV. THE NATURALISTIC PERSPECTIVE

(a) What it is:

This perspective[10] is derived from the premise that society can be considered as a living organism whose primary goals are survival and growth. In this view, scientific and technological processes have to be considered and understood in terms of their systematic relationships with economic, political, socio-cultural and psychological processes. Scientific, technological and economic processes can be further viewed in the context of their domestic and international ramifications. Similarly, political processes may be decomposed into those which are organized and those which are unorganized; socio-cultural processes may be sub-divided for conceptual clarity between stabilizing and change-oriented processes; and psychological processes may be viewed in terms of how they generate material and non-material needs for individuals and society. And in the naturalistic framework, these processes and sub-processes have to be analyzed and understood in terms of their inter-relationships and their relationships to the social organism as a whole.

Alternatively, the naturalistic perspective can be interpreted in relation to the various sections of the society. For instance, by extending the biological analogy, we can conceive of scientists and technologists as those organs of the social organism which form the brain of the society in that they record, process and analyse information in order to help direct the activities of the social organism. Resource owners, managers and administrators, on the other hand, can be conceived as analogous to the autonomous nervous system which manages the day-to-day activities of the social organism. Thirdly workers and farmers can be conceived of as limbs of the social organism. In this organic-naturalistic perspective, the scientific and technological processes are only a sub-set of processes which contribute to the survival and growth of the total social organism. In this Spencerian view, societies are perceived as evolving organism in very much the same way as biological evolution is perceived.

(b) Some working concepts:

To promote the naturalistic concept of scientific and technological processes, the following concepts are useful. As the naturalistic conception is based on a natural science concept, it becomes necessary in a scientific vein to perceive the universe as chaos organized by reason or natural law"[11]. That nature and universe are governed by fundamental natural laws is a basic concept coming out of the scientific revolutions during the last 4 to 5 centuries. The natural laws which are immediately applicable to our naturalistic concept of society are analogous to the natural laws of biological survival, evolution and growth. Thus, the concept of natural law becomes the working principle of the naturalistic concept.

Another important concept from nature and science is that of balance and harmony of forces both in organic and inorganic systems. In natural and social sciences, this concept of balance and harmony is often interpreted in terms of static and dynamic equilibrium and quasi-equilibrium. In social sciences, this concept presupposes the continuous existence of conflict, but proposes that conflict is to be managed dynamically to maintain social balance and harmony. For scientists and technologists, this concept can be interpreted in terms of the need for maintaining balance between knowledge and between personal gains and collective welfare. The agenda for the organic analyst is to discover, through the scientific method, natural laws which govern society, and the forces which keep (or do not keep) social organisms in dynamic equilibrium, or move them from quasi-equilibrium to quasi-equilibrium.

(c) How this perspective can be applied:

As suggested in the enunciation of this perspective above, scientific and technological processes have to be viewed as intimately linked with other social processes, in the same way as scientists and technologists have to be viewed as intimately linked with other sections of the society.

To extend the analogy further, the scientific and technological processes within a social organism are perceived as the organism's brain. We can imagine a society with a brain (i.e. science and technology) transplantation. Such a society would be characterized by scientific and technological processes either being maintained by the nurturing systems of the social organism, or by being linked up with external sources of sustenance and growth. In the second case, we have a situation where the scientific and technological process within a social organism becomes too dependent on the nature of such processes outside the social organism, and thus, may curtail the autonomy of the social organism. A good example of this kind of a transplanted scientific and technological framework is the Indian society, where we find that the scientific and technological processes are excessively

nurtured by these processes outside the Indian society[12]. There is no need here to review the substantial literature which argues that scientific and technological processes in India have not been internalized by the society at large.

On the other hand, an examination of the social, economic and technological history of Japan shows that the naturalistic approach to scientific and technological processes has played a very important role in that country's development[13]. In Japanese development, it is found that the concept of natural law has been significant in the formation of the Japanese world-view. Furthermore, the Japanese writers, since 17th century particularly, have emphasized the need for basing knowledge on action and action on knowledge. Japanese history from the 6th century onwards shows that the rulers of Japan conscientiously and actively integrated scientific, technological and economic activities with not only natural, social and political but also religious activities. This follows from the existential character of the Zen Buddhist view of the universe. Furthermore, various tenets of Taoism have promoted the concepts of naturalism and the corollary notions of balance and harmony between man and nature, and more importantly, among all natural forces and elements. The concepts of natural law have been used in Japan not only to interpret physical and biological nature but also to understand social realities. Sometimes, the emphasis on natural law has been pushed to an extreme. For instance, many economic and scientific and technological activities have been characterized as natural, very much in the naturalistic organic sense. More specifically, many rulers and advisers to rulers in Japan have forcefully argued that social progress based on scientific and technological change leading to a more productive society is not only natural but also ethical. To give just one example, Kaiho Seiryo (1755-1817) is only one of such powerful individuals who influenced Japan's history in this naturalistic context. In particular, he developed the conceptions of the laws of economic balance and the laws of realization commodities, and argued that not only these economic and technological laws but also the realization of gain in social welfare from the exploitation of the physical and natural universe are the "Natural Principles of Heaven and Earth"[14].

It has been argued in this paper that a naturalistic organic perspective of scientific and technological processes, based on the extension of the biological analogy of organic survival and growth, can help us view these processes as an integral and endogenous part of overall social activity and development. The acceptance of this view could suggest that researchers have to focus their attention on identifying natural laws which govern social processes, on recognizing the various forces which produce social conflict, and discovering ways of managing these conflicts in the context of natural-organic-social harmony and balance. Furthermore, the naturalistic perspective suggests that natural and social scientists, technologists-technocrats, and experts and professionals need to work towards internalizing these

processes by popularizing the scientific temper in society at large, by maintaining a balance between knowledge and action and between personal gains and collective gains, and by consciously directing these processes towards the naturalistic survival and growth of the social organism.

NOTES AND REFERENCES

1. *By the word "processes" we mean those dynamic aspects of science and technology which are not only purely intellectual in nature, but are also institutional, inter-personal, and social, i.e. activities through which science, technology and society interface with one another.*

2. *In the phrase "experts and scientists" we include natural scientists, social scientists and all professionals whose basic training is in fundamental or applied natural or social sciences. In the same vein, the meanings included in the word "technology" are: hard, physical technologies and soft, organisational and managerial technologies.*

3. *For socio-political views of the issues related to this interface, see e.g., Collinridge, David, The Social Control of Technology, London: Frances Pinter, 1980, and Benvenist, Guy, The Politics of Expertise, Berkeley: The Glendessary Press, 1972, among others.*

4. *Parts of the following discussion and the discussions in sections IV(v) and (c) below are based on an earlier paper by Waqif, Arif A, "Generalists vs Specialists: Alternate Conceptions of Technology and Education for Development" [unpublished mimeo, delivered as a Faculty Seminar Presentation to the College of Social Sciences and Humanities, Pahlavi (Shiraz) University, Iran, May 1978].*

5. *For some provocative views on what science and technology (in the general sense assumed here) ought to do for society, see Schumacher, E.F., Small is Beautiful, New York: Perennial Library, 1973, and Schumacher, E.F., A Guide for the Perplexed, London: Jonathan Cape, 1977.*

6. *Ellul, Jacques, The Technological Society, London: Jonathan Cape, 1965.*

7. *Ellul, Jacques, The Technological Society, op. cit. and Ellul, Jacques, The Technological System, New York: Continuum, 1980.*

8. *Schumacher, E.F., Small is Beautiful, op. cit.*

9. *Mishan, E.J., Technology and Growth: The Price We Pay, New York: Praeger, 1970.*

10. *The following discussion is based partly on Waqif, Arif A., "Technology and the Social Organism," Kayhan International, Tehran, May 1977.*

11. *Part of this discussion is based on Waqif, Arif A., "The Religious Background of Japanese Capitalism with a Comparative Perspective on China and India," Journal of Social Sciences and Humanities, Vol. 1, No.2, Summer 1979.*

12. *Consider, in this respect, the extent to which the scientific and technological processes in any country (e.g. India, Japan or USA) become dependent on external sources (i.e., sources external to the social organism) for sustenance and growth. A good example in this respect is the extent to which Indian scientists and technologists (including social scientists and professional managers and administrators) depend on foreign sources of sustenance and growth, like foreign journals, foreign jobs, and international recognition, not to mention foreign funds and other facilities made available by foreign sources to this scientific and professional establishment.*

13. *Waqif, A.A., 1979, op. cit.*

14. *Ibid. For reference sources on Japanese and Indian intellectual traditions, see Tsunoda, Ryusaku, et al, Sources of Japanese Tradition, New York, Columbia University Press, 1964; Moore, C.A., (ed) The Japanese Mind, Honolulu: East-West Center Press, (1967); and Moore, C.A., (ed) The Indian Mind: Essentials of Indian Philosophy and Culture, Honolulu: East-West Center Press, 1958.*

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